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PROJECTIONS OF DEMAND FOR WATERBORNE TRANSPORTATION, OHIO RIVER--ETC(U)
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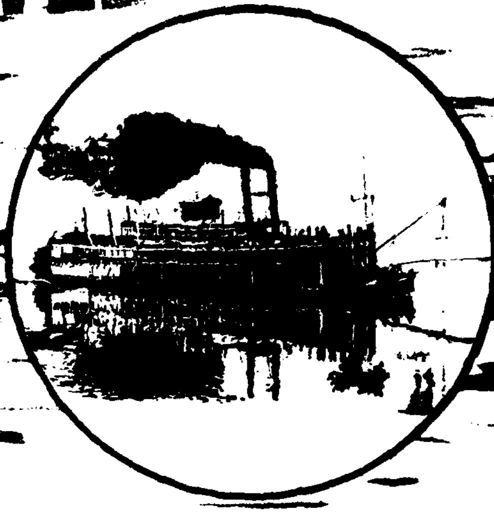
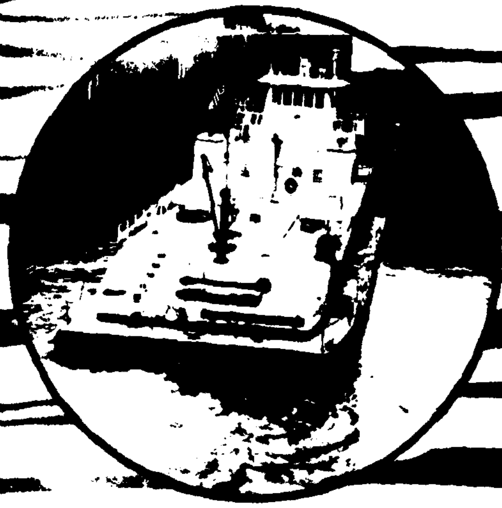
Projections Of Demand For Waterborne Transportation

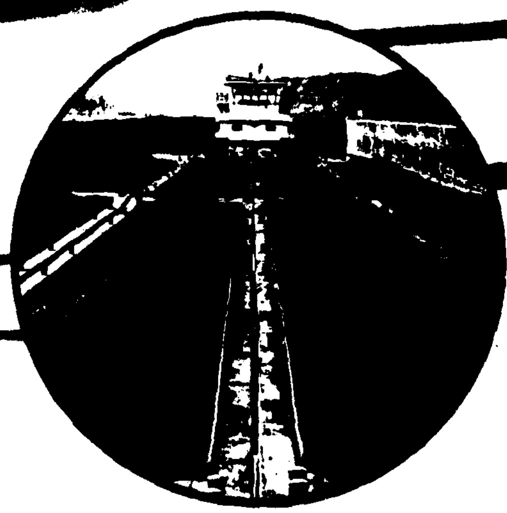
Ohio River Basin
1980 - 2040



Volume 9

Ores and Minerals





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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER	2. GOVT ACCESSION NO. AD-A094
3. RECIPIENT'S CATALOG NUMBER 365	
4. TITLE (and Subtitle) Projections of Demand for Waterborne Transportation, Ohio River Basin 1980, 1990, 2000, 2020, 2040; Vol. 9, Group VII: Ores and Minerals A094 364	5. TYPE OF REPORT & PERIOD COVERED Vol. 9 of 17
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s)	8. CONTRACT OR GRANT NUMBER(s) DACW69-78-C-0136
9. PERFORMING ORGANIZATION NAME AND ADDRESS Robert R. Nathan Associates, Inc. Consulting Economists 1301 Pennsylvania Ave., N.W. Washington, DC 20004	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS Ohio River Basin Navigation Studies
11. CONTROLLING OFFICE NAME AND ADDRESS U.S. Army Corps of Engineers, Ohio River Div. ATTN: Navigation Studies Branch, Planning Div. P.O. Box 1159, Cincinnati, OH 45201	12. REPORT DATE December 1980
	13. NUMBER OF PAGES 61
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) U.S. Army Corps of Engineers, Huntington District P.O. Box 2127 Huntington, WV 25721	15. SECURITY CLASS. (of this report) Unclassified
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for Public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Bulk cargo	Market demand analysis	Ores
Commodity resource inventory	Modal split analysis	Minerals
Economic development	Ohio River Basin	
Economic forecasting	River basin development	
Inland waterways	Traffic surveys	

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This Corps of Engineers report describes one of three independent but complementary studies of future freight traffic on the Ohio River Basin Navigation System. Each of the studies considers existing waterborne commerce and develops a consistent set of projects of future traffic demands for all of the navigable waterways of the Basin. Each report contains information on past and present waterborne commerce in the Basin and projections by commodity groups and origin-destination areas from 1976 to at least 1990.

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(Continued from #20)
The three study projections, in conjunction with other analytical tools and system information, will be used to evaluate specific waterway improvements to meet short and long-term navigation needs. The output from these studies will serve as input to Corps' Inland Navigation Simulation Models to help analyze the performance and opportunities for improvement of the Ohio River Basin Navigation System. These data will be used in current studies relating to improvement of Gallipolis Locks, the Monongahela River, the Upper Ohio River, the Kanawha River, the Lower Ohio River, the Cumberland River and the Tennessee River, as well as other improvements.

This document is volume 9 of the 17 volume report shown below.

The study included a Commodity Resource Inventory, a Modal Split Analysis and a Market Demand Analysis. The work included investigation and analyses of the production, transportation and demand characteristics of each of the major commodities transported on the Ohio River and its tributaries. For each of 15 commodity groups, the demand for waterway transportation into, out of and within the Ohio River Basin was projected through the year 2040. A detailed study analysis and discussion for each commodity group is presented in 15 individually bound reports, supplemented by a methodology report. A study summary aggregates the commodity group totals for each of the several projections periods and lists the total waterborne commerce for each of the 72 operational locks and dams in the Ohio River Basin. The study results are presented in the following 17 documents:

Volume	Subject Title	
1	Study summary	
2	Methodology	
3	Group I:	Coal and coke
4	Group II:	Petroleum fuels
5	Group III:	Crude Petrol.
6	Group IV:	Aggregates
7	Group V:	Grains
8	Group VI:	Chemicals and chemical fertilizers
9	Group VII:	Ores and Minerals
10	Group VIII:	Iron ore, steel and iron
11	Group IX:	Feed and food products, nec.
12	Group X:	Wood and paper products
13	Group XI:	Petroleum products, nec.
14	Group XII:	Rubber, plastics, nonmetallic, mineral, products, nec.
15	Group XIII:	Nonferrous, metals and alloys, nec.
16	Group XIV:	Manufactured products, nec.
17	Group XV:	Other, nec.

Additionally, an Executive Summary is available as a separate document.

Final Rept.

GROUP VII. ORES AND MINERALS.

PROJECTIONS OF DEMAND FOR WATERBORNE TRANSPORTATION, OHIO RIVER BASIN, 1980, 1990, 2000, 2020, 2040. Volume 9.

Prepared for

U.S. ARMY CORPS OF ENGINEERS

OHIO RIVER DIVISION, HUNTINGTON DISTRICT

Contract No. DACW69-78-C-0136

by

Robert R. Nathan Associates, Inc.
Consulting Economists
Washington, D.C.

DECEMBER 1980

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Robert R. Nathan Associates, Inc.
Projections of demand for waterborne transportation, Ohio River Basin, 1980, 1990, 2000, 2020, 2040 / Prepared for the U.S. Army Corps of Engineers, Huntington District ... by Robert R. Nathan Associates, Inc., December 1980. Cincinnati, Ohio : U.S. Army Corps of Engineers, Ohio River Division, 1980.
17 v. : ill. ; 28 cm.
Contract DACW69-78-0136.
"...one of three independent but complementary studies of future freight traffic on the Ohio River Basin Navigation System."

CONTENTS: v.1. Study summary.--v.2. Methodology.--v.3. Commodity groups .

1. Shipping--Ohio River Basin. 2. Inland water transportation--Ohio River Basin--Statistics. 3. Ohio River Basin. I. United States. Army. Corps of Engineers. Ohio River Division. II. United States. Army. Corps of Engineers. Huntington District. III. Title.

HE597.03N3 OCLC no. 7030444

PREFACE

This Corps of Engineers report describes one of three independent but complementary studies of future freight traffic on the Ohio River basin navigation system. Each of the studies considers existing waterborne commerce and develops a consistent set of projections of future traffic demands for all of the navigable waterways of the basin. Each report contains information on past and present waterborne commerce in the basin with projections by commodity group and origin-destination areas from 1976 to either 1990 or 2040.

The three projections, in conjunction with other analytical tools and waterway system information, will be used to evaluate specific waterway improvements required to meet short and long-term navigation needs. The output from these studies will serve as input to Corps inland navigation simulation models to help analyze the performance and requirements for improvements of the Ohio River basin navigation system. These data will be used in current studies relating to improvements of Gallipolis Locks, the Monongahela River, the Upper Ohio River, the Kanawha River, the Lower Ohio River, and the Tennessee River, as well as for other improvements.

The reports on the three studies are referred to as the "CONSAD," the "BATTELLE," and the "NATHAN" reports. The latter and final report was completed in November 1980. It was prepared for the Corps of Engineers by Robert R. Nathan Associates, Inc., Consulting Economists, Washington D.C. This study encompasses the period 1976-2040, and is by far the most detailed of the three.

The "CONSAD" report, completed in January 1979, was prepared for the Corps by the CONSAD Research Corporation of Pittsburgh, Pennsylvania. The study and the 1976-1990 projected traffic demands discussed in that report were developed by correlating the historic waterborne commodity flows on the Ohio River navigation system, with various indicators of regional and national demands for the commodities. The demand variables which appeared to best describe the historic traffic pattern for each of the commodity groups was selected for projection purposes. The projected values for the demand variables are based upon the 1972 OBERS Series E Projections of National and Regional Economic Activity. The OBERS projections serve as national standards and were developed by the Bureau of Economic Analysis of the U.S. Department of Commerce, in conjunction with the Economic Research Service of the Department of Agriculture.

The "BATTELLE" report was completed in June 1979, and was prepared for the Corps by the Battelle Columbus Laboratories, Columbus, Ohio. The study and the 1976-1990 traffic projections discussed in that report were developed by surveying all waterway users in the Ohio River Basin through a combined mail survey and personal interview approach. The purpose of the survey was to obtain an estimate from each individual shipper of his future commodity movements, by specific origins and destinations, as well as other associated traffic information. All identifiable waterway users were contacted and requested to provide the survey information. In addition, personal interviews were held with the major shippers. The responses were then aggregated to yield projected traffic demands for the Ohio River navigation system.

The "NATHAN" report presents the findings of a commodity resource inventory, a modal split analysis and a market demand analysis. The work included investigation and analyses of the production, transportation, and demand characteristics of each of the major commodities transported on the Ohio River and its tributaries. For each of 15 commodity groups, the demand for waterway transportation into, out of, and within the Ohio River basin was projected through the year 2040. A detailed study analysis and discussion for each commodity group is presented in 15 individually bound reports, supplemented by a methodology report. A Study Summary and an Executive Summary present appropriately abbreviated discussion and findings resulting from these analyses. The Study Summary aggregates the commodity group totals for each of the several projection periods and lists the total waterborne commerce for each of the 72 operational locks and dams in the Ohio River Basin.

The "NATHAN" report, "Projections of Demand for Waterborne Transportation, Ohio River Basin, 1980, 1990, 2000, 2020, 2040" consists of the following volumes:

Subject Title	Number of Pages	Volume Number
Study Summary	220	1
Methodology	118	2
Group I: Coal and Coke	134	3
Group II: Petroleum Fuels	66	4
Group III: Crude Petroleum	42	5
Group IV: Aggregates	64	6
Group V: Grains	131	7
Group VI: Chemicals and Chemical Fertilizers	90	8
Group VII: Ores and Minerals	61	9
Group VIII: Iron Ore, Steel and Iron	104	10
Group IX: Feed and Food Products, Nec.	44	11
Group X: Wood and Paper Products	61	12
Group XI: Petroleum Products, Nec.	38	13
Group XII: Rubber, Plastic, Nonmetallic Mineral Products, Nec.	41	14
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Group XIV: Manufactured Products Nec.	35	16
Group XV: Others, Nec.	48	17

Additionally, an Executive Summary is available as a separate document.

RRNA

PROJECTIONS OF DEMAND FOR WATERBORNE TRANSPORTATION OHIO RIVER BASIN 1980, 1990, 2000, 2020, 2040

Group VII: Ores and Minerals

Prepared for
U.S. Army Corps of Engineers
Huntington District
Contract No. DACW69-78-C-0136

by
Robert R. Nathan Associates, Inc.
Consulting Economists
Washington, D.C.

November 1980

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I. INTRODUCTION

Group VII, ores and minerals, consists of nonferrous ores and metallic and nonmetallic minerals, excluding fuels. During the 1969-76 period, these commodities accounted for an average of 2.1 percent of total Ohio River System (ORS) traffic. The bulk of this traffic was inbound shipments to the Ohio River Basin (ORB).

The areas within the Ohio River Basin for which projections of Group VII consumption, production and movements have been made are designated as Primary Study Areas (PSAs). The PSAs for Group VII are those U.S. Department of Commerce Bureau of Economic Analysis Areas (BEAs) and area segments (aggregations of counties within a BEA) which are origins or destinations of Group VII waterborne movements. A map showing Group VII PSAs is presented in the appendix to this report.

In addition to the PSAs, external areas linked to the ORB through waterborne commerce have been identified. Areas (BEAs) outside the ORB which are destinations of waterborne Group VII movements originating in the ORB are designated as Secondary Consumption Areas (SCAs). Areas (BEAs) outside the ORB which are origins of Group VII waterborne movements destined to the ORB are designated as Secondary Production Areas (SPAs).

A. Description of Group VII

The individual commodities included in Group VII are:

Waterborne Commerce Statistics Code (WCSC)	Commodity/Product
1021	Copper ore and concentrates
1051	Bauxite and other aluminum ores and concentrates

1061	Manganese ores and concentrates
1091	Nonferrous metal ores and concentrates, not elsewhere classified, (nec.)
1451	Clay, ceramic and refractory materials
1491	Salt
1492	Sulfur, dry
1493	Sulfur, liquid
1494	Gypsum, crude and plasters
1499	Nonmetallic minerals, except fuels, nec.

Historical data and discussions with industrial authorities indicate that only five commodities within Group VII may be expected to generate significant future waterborne traffic flows in the ORS. These products are:

- Bauxite and other aluminum ores and concentrates (WCSC 1051)
- Manganese ores and concentrates (WCSC 1061)
- Nonferrous metal ores and concentrates, nec. (WCSC 1091)
- Salt (WCSC 1491)
- Liquid sulfur (WCSC 1493).

In 1976, these five commodities accounted for an average of 95 percent of total ore and mineral movements in the ORS. Other ores and minerals, including WCSCs 1021, 1451, 1492, 1494 and 1499, generated only random or small movements. It is not anticipated that any of these commodities will be transported by water in significant quantities in the future.

B. Existing Waterway Traffic Flows

The total inbound, outbound and local ore and mineral traffic in the ORS was recorded at about 3.6 million tons in 1969. This increased to a peak of 4.5 million tons in 1971 and dropped to 3.2 million tons in 1973. By 1976, total shipments had, once again, reached a level of 4.5 million tons (Table 1). In 1976, ores and minerals accounted for 2.2 percent of all waterborne shipments in the ORS (Table 2).

Overall, the bulk of Group VII traffic consists of inbound movement to the ORB. From 1969 to 1976, waterborne shipments of Group VII commodities from port equivalents (PEs) outside the ORB to port equivalents in the ORB (i.e., inbound traffic) increased at an average rate of 1.9 percent per annum. Outbound and local traffic experienced fluctuations but generally increased over the study period. In 1976, 3.9 million of the 4.5 million tons of ores and minerals transported by water in the Ohio River System were inbound shipments (Table 1).

BEAs 66 (Pittsburgh), 115 (Paducah) and 62 (Cincinnati) were the major destinations of waterborne shipments of ores and minerals during the 1969-76 period. In 1976, these three BEAs received 833 thousand, 572 thousand and 670 thousand tons of inbound waterborne ores and minerals, respectively. These BEAs accounted for 53 percent of the total Group VII inbound traffic (Table 3).

The remaining inbound receipts of ores and minerals in the ORS were fairly evenly distributed among the PSAs. In 1976, of the remaining ten PSAs which received ore and mineral commodities by water, seven had waterborne Group VII receipts of over 100 thousand tons.

Outbound and local waterborne movements of ores and minerals in the ORS are relatively insignificant in size and random in occurrence. The only exceptions are the outbound and local shipments of manganese, and local movements of clay which, during several years, had movements of over 100 thousand tons. In the case of manganese ore and concentrates, shipments represent interplant transfers which are expected to continue at current levels in the future.

Table 1. Ohio River System: Waterborne Shipments of Ores and Minerals by Commodity Inbound, Outbound, and Local Movements, 1969-76

(Thousands of tons unless otherwise specified)

Commodity and type of movement	1969	1970	1971	1972	1973	1974	1975	1976	Average annual percentage change, 1969-76
Total	3,558.0	3,966.9	4,482.2	3,744.4	3,160.5	3,819.3	3,523.8	4,451.0	3.3
Inbound	3,371.5	3,810.1	4,233.9	3,345.9	2,808.7	3,235.0	3,132.4	3,905.1	2.1
Outbound	47.7	39.1	77.0	73.9	113.3	185.7	117.2	325.1	31.6
Local	138.8	117.7	171.3	324.6	238.5	398.6	274.2	220.8	6.9
Copper	--	--	--	1.4	--	--	--	1.1	a
Inbound	--	--	--	1.4	--	--	--	1.1	a
Outbound	--	--	--	--	--	--	--	--	--
Local	--	--	--	--	--	--	--	--	--
Bauxite	--	--	26.2	3.4	24.3	4.1	3.0	492.4	a
Inbound	--	--	26.2	3.4	1.5	2.9	1.6	492.4	a
Outbound	--	--	--	--	22.8	--	--	--	--
Local	--	--	--	--	--	1.2	1.4	--	--
Manganese	646.3	623.3	1,188.7	852.3	801.3	1,044.1	958.0	851.8	4.0
Inbound	604.4	590.5	1,080.8	715.8	616.2	591.0	684.3	564.7	(1.0)
Outbound	0.6	10.7	35.9	27.9	58.9	146.0	84.0	103.4	108.7
Local	41.3	22.1	72.0	108.6	126.2	307.1	189.7	183.7	23.8
Nonferrous, nec.	415.4	630.5	640.1	371.8	283.6	302.0	391.7	586.2	5.0
Inbound	400.6	602.6	600.9	331.8	253.8	280.9	362.7	385.7	(0.5)
Outbound	2.7	4.6	26.7	25.6	10.5	7.6	6.8	188.5	83.4
Local	12.1	23.3	12.5	14.4	19.3	13.5	22.2	12.0	(0.1)
Clay materials	85.0	54.6	44.8	132.5	112.1	88.8	79.6	38.6	(10.7)
Inbound	17.8	12.0	12.9	9.6	37.9	17.2	23.2	29.7	7.6
Outbound	23.5	21.8	14.4	12.7	14.8	19.8	12.2	5.6	(18.5)
Local	43.7	20.8	17.5	110.2	59.4	51.8	44.2	3.3	(30.9)

(Continued)

Table 1. (Continued)

Commodity and type of movement	1969	1970	1971	1972	1973	1974	1975	1976	Average annual percentage change, 1969-76
Salt	1,844.3	2,176.8	2,113.3	1,768.4	1,434.0	1,738.7	1,643.5	1,807.7	(0.3)
Inbound	1,827.4	2,165.7	2,090.6	1,746.2	1,431.8	1,738.0	1,643.5	1,805.7	(0.2)
Outbound	16.9	1.4	--	--	--	--	--	--	--
Local	--	9.7	22.7	22.2	2.2	0.7	--	2.0	a
Sulphur, dry	9.8	2.3	1.5	1.6	--	0.8	--	--	--
Inbound	8.5	2.3	1.5	1.6	--	0.8	--	--	--
Outbound	1.3	--	--	--	--	--	--	--	--
Local	--	--	--	--	--	--	--	--	--
Sulphur, liquid	387.2	295.1	269.5	305.2	266.0	313.6	167.4	187.3	(9.9)
Inbound	355.5	272.7	257.0	285.4	266.0	313.6	166.2	187.3	(8.7)
Outbound	--	--	--	3.3	--	--	--	--	--
Local	31.7	22.4	12.5	16.5	--	--	1.2	--	--
Gypsum, crude, plasters	--	--	--	--	0.3	--	--	--	--
Inbound	--	--	--	--	--	--	--	--	--
Outbound	--	--	--	--	0.3	--	--	--	--
Local	--	--	--	--	--	--	--	--	--
Nonmetallic minerals, Nec.	169.9	184.2	198.0	307.9	238.9	327.3	280.8	486.3	16.2
Inbound	157.3	164.2	164.0	250.8	201.5	290.7	250.9	438.7	15.8
Outbound	2.7	0.6	--	4.4	6.0	12.3	14.3	27.8	39.5
Local	9.9	19.4	34.0	52.7	31.4	24.3	15.6	19.8	10.4

Note: Individual items may not add to totals due to rounding.

a. No tonnages reported in 1969.
b. Waterborne statistics for 1976 reflect findings of an extensive shipper survey. It is believed that significant tonnages of bauxite were shipped in earlier years, and not reported.

Source: Compiled by RRNA from Waterborne Commerce by Port Equivalents, 1969-76, supplied by the U.S. Army Corps of Engineers.

Table 2. Ohio River System: Waterborne
Shipments of All Commodities and of Ores and Minerals, 1976

(Thousands of tons unless otherwise specified)

	Total	Inbound	Outbound	Local
All commodities	200,770.5	29,439.5	26,854.0	144,477.0
Ores and minerals	4,451.0	3,905.1	325.1	220.8
As a percentage of all commodities	2.2	13.3	1.2	0.2

Source: Compiled by RRNA from _Waterborne Commerce by Port Equivalents_, revised 1976, supplied by U.S. Army Corps of Enginners.

Table 3. Ohio River Basin: Waterborne Commerce by BEA, 1976
Group VII: Ores and Minerals

(Thousands of tons)

		Destination													
Origin	Total	ORB BEAs	BEA 47	BEA 48	BEA 49	BEA 50	BEA 52	BEA 54	BEA 55	BEA 62	BEA 64	BEA 65	BEA 66	BEA 68	BEA 115
TOTAL	4,451.0	4,125.9	168.0	153.5	279.6	6.6	228.6	81.2	659.7	670.1	313.9	50.1	833.3	109.0	572.3
ORB BEAs	545.9	220.8	1.1	21.1	--	--	52.4	--	7.8	--	18.0	--	9.8	6.6	104.0
BEA 47	47.0	47.0	--	--	--	--	--	--	--	--	--	--	--	--	47.0
BEA 48	1.1	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BEA 49	185.1	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BEA 52	71.2	71.2	--	--	--	--	--	--	4.5	--	14.0	--	6.7	--	46.0
BEA 55	53.1	19.6	--	--	--	--	13.4	--	--	--	--	--	3.1	3.3	--
BEA 64	27.4	24.1	1.1	--	--	--	14.0	--	--	--	--	--	--	--	9.0
BEA 66	144.9	44.7	--	21.1	--	--	13.0	--	3.3	--	4.0	--	--	3.3	--
BEA 68	1.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BEA 115	15.1	14.0	--	--	--	--	12.0	--	--	--	--	--	--	--	2.0
Non-ORB BEAs	3,905.1	3,905.1	166.9	132.4	279.6	6.6	176.2	81.2	651.9	670.1	295.9	50.1	823.5	102.4	468.3
BEA 38	3.3	3.3	--	--	--	--	--	--	--	--	--	--	3.3	--	--
BEA 77	30.3	30.3	--	--	--	--	--	--	1.1	--	--	--	2.2	--	27.0
BEA 78	4.5	4.5	--	--	--	--	--	--	--	--	--	--	4.5	--	--
BEA 81	1.1	1.1	--	--	--	--	--	--	--	--	--	--	1.1	--	--
BEA 91	16.3	16.3	--	--	--	--	--	--	--	5.5	--	--	10.8	--	--
BEA 113	1.0	1.0	--	--	--	--	1.0	--	--	--	--	--	--	--	--
BEA 114	10.0	10.0	--	--	--	--	--	--	--	8.9	1.1	--	--	--	--
BEA 115[a]	45.2	45.2	--	--	--	--	--	--	--	2.2	--	--	--	--	43.0
BEA 137	145.8	145.8	--	--	76.8	--	--	--	69.0	--	--	--	--	--	--
BEA 138	2,987.2	2,987.2	166.9	132.4	202.8	6.6	167.4	81.2	252.7	571.9	294.8	50.1	625.5	36.6	398.3
BEA 139	53.0	53.0	--	--	--	--	--	--	--	53.0	--	--	--	--	--
BEA 140	8.9	8.9	--	--	--	--	--	--	--	8.9	--	--	--	--	--
BEA 141	20.0	20.0	--	--	--	--	--	--	--	--	--	--	17.8	2.2	--
BEA 143	333.4	333.4	--	--	--	--	--	--	329.1	--	--	--	4.3	--	--
BEA 144	245.1	245.1	--	--	--	--	7.8	--	--	19.7	--	--	154.0	63.6	--

(Continued)

Table 3. (Continued)

Origin	Destination: Non-ORB BEAs	BEA 38	BEA 45	BEA 46	BEA 77	BEA 91	BEA 107	BEA 114	BEA 119	BEA 137	BEA 138	BEA 140	BEA 144
TOTAL	325.1	22.3	6.7	1.1	22.9	17.0	1.0	2.2	1.1	15.6	201.1	6.0	28.1
ORB BEAs	325.1	22.3	6.7	1.1	22.9	17.0	1.0	2.2	1.1	15.6	201.1	6.0	28.1
BEA 47	--	--	--	--	--	--	--	--	--	--	--	--	--
BEA 48	1.1	--	--	--	--	--	--	1.1	--	--	--	--	--
BEA 49	185.1	--	--	--	--	17.0	--	--	--	--	150.0	--	18.1
BEA 52	--	--	--	--	--	--	--	--	--	--	--	--	--
BEA 55	33.3	--	--	--	20.7	--	--	--	1.1	--	5.5	6.0	--
BEA 64	3.3	--	--	--	2.2	--	--	1.1	--	--	--	--	--
BEA 66	100.2	22.3	6.7	1.1	--	--	--	--	--	15.6	44.5	--	10.0
BEA 68	1.0	--	--	--	--	--	1.0	--	--	--	--	--	--
BEA 115	1.1	--	--	--	--	--	--	--	--	--	1.1	--	--
Non-ORB BEAs													
BEA 38													
BEA 77													
BEA 78													
BEA 81													
BEA 91													
BEA 113													
BEA 114	** Traffic external to Ohio River System**												
BEA 115[a]													
BEA 137													
BEA 138													
BEA 139													
BEA 140													
BEA 141													
BEA 143													
BEA 144													

a. Consists of counties external to Ohio River Basin.
Source: U.S. Army Corps of Engineers, Waterborne Commerce by Port Equivalents, revised 1976.

C. Summary of Study Findings

In the PSAs, consumption levels for ores and minerals are far greater than the area's ability to produce these materials. The area served by the ORS does not possess significant reserves of most ores and minerals.

Consumption of ores and minerals is expected to grow at an average annual rate of 4.4 percent through 2000. In 2000, consumption of ores and minerals in the PSAs is projected to be 19.0 million tons as compared with the 6.7 million tons consumed in 1976.

Although production is expected to grow at an average annual rate of 3.3 percent through the year 2000, it will remain relatively insignificant compared to the level of ores and minerals consumption in the PSAs. Thus, the consumption of ores and minerals is expected to remain the dominant factor in determining waterborne movements of these commodities in the ORS.

Waterborne movements of ores and minerals in the ORS are expected to increase at an average annual rate of 4.2 percent through 2000. Movements should reach a level of 11.8 million tons by that year.

II. MARKET DEMAND ANALYSIS

Consumption of the ores and minerals commodity group in the PSAs averaged over 5.9 million tons per year during 1969-76. Except for 1976, when over 6.7 million tons of ores and minerals were used, total consumption remained fairly stable. Wide differences in commodity uses for the individual ores or minerals have tended to produce a stabilizing impact on the overall consumption of the group in any given year.

A. Market Areas

In addition to local demand for Group VII commodities produced in the PSAs, demand also is generated by Secondary Consumption Areas (SCAs) located outside the ORB. These SCAs are defined as BEAs which are the destinations of waterborne ore and mineral movements originating in the Ohio River Basin.

A-1. Primary Study Areas (PSAs)

This study has identified 13 BEAs and BEA segments in the ORB which either have been or will be the ultimate origins or destinations of waterborne ore and mineral commodity movements. Appendix Table A-1 presents the BEAs and BEA segments which constitute the PSAs for ores and minerals and for which ore and mineral consumption has been analyzed and projected.

A-2. Secondary Consumption Areas (SCAs)

BEAs outside the Ohio River Basin which are destinations of waterborne shipments from the ORB were not segmented, nor was any attempt made to analyze or project consumption in these BEAs. Such efforts were not warranted because of the low volume of historical and projected shipments from the ORB to Secondary Consumption Areas.

B. Product Uses

The uses of ores and minerals vary widely among individual commodities. Generally, manganese ore is consumed by the steel industry in the production of ferroalloys and steel, while liquid sulfur is used in the manufacture of sulfuric acid by the chemical industry. Rock salt is used for the deicing of roads and highways during the winter months. Zinc ore is consumed by the primary metals industry in the manufacture of slab zinc metal. Bauxite or alumina is consumed by the producers of aluminum metal and products.

B-1. Manganese Ore and Concentrates

The principal use of manganese is for the production of iron and steel. Although some manganese ore and concentrate is directly fed into steelmaking furnaces, it is usually converted into ferromanganese or silicomanganese prior to its use by the steel industry.

Manganese, in one of the above forms, is essential to the production of steel because of the alloying characteristics it imparts to steel: strength, toughness, hardness and solidity. In addition, manganese provides desulfurization and deoxidizing elements for the steel production process.

Manganese, in the form of manganese dioxide, is also used in the common dry-cell battery as a depolarizer. Other uses of manganese are as a fluxing agent in the smelting of base metal ores and as a trace element in fertilizer and animal and poultry feeds.

B-2. Liquid Sulfur

The principal consumer of sulfur is the chemical industry which uses sulfur as a chemical reagent with other chemicals. In most cases, it must be converted to an intermediate chemical product prior to its usage as a processing chemical. For instance, in 1974, 90 percent of the sulfur consumed in the United States had been either converted to sulfuric acid or produced directly in that form.[1] Sulfur also is used in the production of two other intermediate chemical carbon products, desulfide and sulfur dioxide.

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1. U.S. Department of the Interior, Bureau of Mines, "Sulfur," Mineral Facts and Problems, 1975 ed. (Washington, D.C.: GPO, 1976).

B-3. Salt

The salt that is transported into the ORB via the waterway consists of rock salt destined for ORB metropolitan areas for use in deicing roads and highways. This usage of rock salt normally represents, on the average, 15 percent of the total U.S. consumption of all types of salt (including salt in brine and evaporated salt). The major consumer of salt, in general, is the chemical industry. It uses salt as an intermediate product in the formation of other chemicals.

B-4. Zinc Ore and Concentrates

The principal use of zinc ore and concentrates is in the production of zinc metal. Once converted into metal form, zinc is used in galvanizing, in brass and bronze products, in castings, and in rolled zinc. The end-use categories and percentages of use for these zinc products are as follows: construction, 39 percent; transportation, 14 percent; electrical, 13 percent; machinery, 10 percent, and; other zinc metal uses, 14 percent.

A small amount of zinc, primarily in the form of zinc oxide, is consumed in the manufacture of rubber products and paints.

B-5. Alumina Ore and Concentrates

Nearly 90 percent of alumina ore and concentrate consumed domestically is used in the production of aluminum metal. Aluminum is used in many situations where its properties as a light, non-corrosive, non-magnetic, and malleable metal make it highly desirable. These applications are primarily in the construction and transportation industries. Aluminum is used in many residential and commercial buildings as well as in motor vehicles and marine vessels.

Alumina ore is also used in refractories and ceramics and as an abrasive and fire-retardent backing.

C. Consumption Characteristics

The demand for commodities in the ores and minerals commodity group is determined by factors which influence the demands for products for which they are inputs. For example, the demand for manganese ore is principally determined by factors affecting the production of steel, whereas the demand for sulfur is dependent on the level of chemical production in the United States. Consumption of rock salt is unusual in that it is determined chiefly by uncertain factors such as the severity of winter weather in the PSAs and governmental environmental regulations.

C-1. Manganese Ore and Concentrates

The demand for manganese ore and concentrates is directly related to the demand for steel. In the United States, manganese has traditionally been consumed at a rate of 14 pounds per ton of raw steel produced.[1] This is expected to remain relatively stable.

Factors affecting the production of steel in the United States and the PSAs are discussed in the Iron Ore, Steel and Iron (Group VIII) Report. As would be expected, trends in automotive production and construction, as well as the general level of manufacturing in the United States, are most significant in determining the demand for manganese ore and concentrates.

C-2. Sulfur

Since sulfur is used primarily as a chemical reagent in the form of sulfuric acid, its demand is determined chiefly by the derived demand for sulfuric acid. The most important use of sulfuric acid is in the manufacture of fertilizers which accounts for approximately 60 percent of sulfuric acid consumption. Factors affecting fertilizer production are discussed in the Chemicals and Chemical Fertilizers (Group VI) Report. Other uses of sulfuric acid, and consequently sulfur, are determined by the level of manufacturing activity in areas such as plastics and synthetics, paper products, paints and nonferrous metal production.

C-3. Rock Salt

The consumption of rock salt, for highway deicing purposes in the PSAs, is principally determined by the severity of winter weather and the growth in the interstate and intrastate highway systems in the area. During the 1960s, there was an extensive increase in the number of highway miles in the PSAs. This also

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1. U.S. Department of the Interior, Bureau of Mines, "Ferroalloys," Mineral Facts and Problems, 1975 ed. (Washington, D.C.: GPO, 1976).

increased the demand for deicing rock salt. However, during the 1970s, this growth in highway construction stabilized, and coupled with environmental concerns over the detrimental effects on plants and wildlife of extensive salt usage, demand was reduced. There are, currently, no states in the ORB that have passed legislation prohibiting the use of salt for highway deicing, but state and local officials are voluntarily limiting their consumption.

C-4. Zinc Ore and Concentrates

Since zinc is consumed primarily by the construction and transportation industries, factors such as population and income, which are important to production in those two sectors of the economy, also determine the demand for zinc ore and concentrates.

The price and availability of substitutes for zinc, such as aluminum and plastics, also help to determine the level of demand for zinc ore and concentrates. However, except in instances where weight is an important consideration, these materials will not constitute significant future substitutes for zinc.

C-5. Alumina Ore and Concentrates

The demand for alumina ore and concentrates is primarily determined by the overall demand for aluminum metal products. Thus, the level of aluminum used in the production of automobiles, housing and durable goods serves as a strong indicator of the derived demand for alumina ore and concentrates. Factors which may affect the future requirements of alumina include: (1) the trend toward using lighter materials in the production of automobiles and other vehicles; (2) the increased application of alumina in housing and construction; (3) the relatively lower cost of aluminum compared to other metal substitutes. All of these factors indicate an increased usage of aluminum in the future.

D. Existing Aggregate Demands

The demand for commodities in the ores and minerals group remained relatively stable in the PSAs during the 1969-76 period. During that period, consumption of commodities analyzed in this group averaged 3.2 million tons annually. A peak of 3.5 million tons was experienced in 1972 (Table 4). The largest consuming PSA was BEA 66 (Pittsburgh) which, in 1976, consumed roughly 1.4 million tons, more than 42 percent, of the commodities in Group VII.

Table 4. Ohio River Basin: Consumption of Ores and Minerals,[a] by BEAs and BEA Segments,[b] Estimated 1969-76

(Thousands of tons)

BEA and BEA segment	1969	1970	1971	1972	1973	1974	1975	1976
Primary Study Areas	5,629.5	5,702.6	5,462.9	5,913.7	5,692.6	6,418.7	5,799.6	6,720.2
BEA 47: Huntsville, AL	497.8	521.8	516.8	540.3	594.2	668.0	554.1	618.1
BEA 48: Chattanooga, TN	100.4	104.8	102.3	115.4	93.5	197.6	246.9	345.8
BEA 49: Nashville, TN	259.2	280.3	276.8	301.9	274.9	342.1	318.7	380.6
BEA 50: Knoxville, TN	526.4	557.9	551.5	589.5	615.5	698.0	586.2	657.5
BEA 52: Huntington, WV	394.8	419.0	410.5	437.1	411.8	457.7	402.7	437.4
BEA 54: Louisville, KY	146.9	158.9	154.6	168.5	135.3	163.3	161.4	180.7
BEA 55: Evansville, IN	571.9	605.4	598.4	635.6	669.5	897.5	877.8	1,118.9
BEA 62: Cincinnati, OH	185.6	208.2	206.8	230.6	178.3	209.2	209.4	235.3
BEA 64: Columbus, OH	516.8	515.3	483.7	559.6	505.8	510.2	463.1	500.4
BEA 65: Clarksburg, WV	24.7	27.8	27.3	31.4	21.5	33.3	38.8	48.9
BEA 66: Pittsburgh, PA	2,095.1	2,003.4	1,859.4	1,986.0	1,888.4	1,948.0	1,679.5	1,916.8
BEA 68: Cleveland, OH	0.7	0.7	0.7	0.8	0.8	0.8	0.9	1.0
BEA 115: Paducah, KY	309.2	299.1	274.1	317.1	303.1	293.0	260.1	278.8

a. Includes consumption of manganese, liquid sulfur, rock salt, zinc and alumina.
b. BEA segments defined as counties which are origins or destinations of waterborne movements.
Source: Consumption of manganese, liquid sulfur, rock salt, zinc, and alumina from Tables 6-10, respectively.

D-1. Manganese Ore and Concentrates

The consumption of manganese ore and concentrates in the PSAs fluctuated widely during the period of 1969-76 (Table 5). For example, in 1969, 1.3 million tons of manganese ore and concentrates were consumed in the PSAs, and; in 1974, almost 1.5 million. In 1975, however, consumption of this commodity in the PSAs decreased to 1.0 million tons. It increased slightly in 1976. As mentioned earlier, the consumption of manganese in the United States varies directly with the level of steel production and thus reflects fluctuations in steel production during this period.

In the United States, most manganese ore and concentrates are processed into either ferromanganese or silicomanganese prior to its consumption in steel plants. For this reason, the BEAs containing ferroalloy plants are shown as the consuming points of manganese ore and concentrates.

D-2. Sulfur

The consumption of sulfur in the PSAs increased steadily during the 1969-76 study period. This was due to a continuing growth of the chemical industry in the region, as well as an increased usage of sulfuric acid for many industrial purposes. In 1969, consumption of sulfur in the PSAs was recorded at 469 thousand tons (Table 6). By 1976, sulfur consumption in the PSAs reached 585 thousand tons and represented an average annual growth rate of 2.8 percent during the 1969-76 period. The largest sulfur-consuming area was BEA 52 (Huntington) which, in 1976, consumed 98 thousand tons or 17 percent of sulfur requirements in the PSAs.

D-3. Rock Salt

The consumption of rock salt in the PSAs, as well as in other areas of the United States, tends to be concentrated in metropolitan areas with relatively dense populations and extensive highway systems.

The consumption of rock salt in the PSAs fluctuates from year to year in accordance with the severity of the winter weather. In 1969, approximately 928 thousand tons of rock salt were consumed in the PSAs. The level of consumption increased to over 1.2 million

Table 5. Ohio River Basin: Consumption of Manganese Ore, by BEAs or BEA Segments,[a] Estimated 1969-76

(Thousands of tons)

BEA or BEA segment	1969	1970	1971	1972	1973	1974	1975	1976
Primary Study Areas	1,323.9	1,241.1	1,114.4	1,298.3	1,294.7	1,468.2	990.0	1,029.6
BEA 48: Chattanooga, TN	26.6	24.9	22.4	26.1	26.0	23.6	19.9	20.7
BEA 64: Columbus, OH	348.9	327.2	293.7	342.2	341.3	309.3	260.9	271.4
BEA 66: Pittsburgh, PA	695.0	651.7	585.2	681.8	679.8	616.2	519.9	540.7
BEA 115: Paducah, KY	253.4	237.3	213.1	248.2	247.6	224.4	189.3	196.8

Note: A factor representing the amount of manganese ore consumed per ton of ferroalloy produced nationally was applied to RRNA's estimates for ferroalloy production by BEA segment. The factor applied was .652 tons of manganese ore per ton of ferroalloy produced.

a. BEA segments defined as counties which are ultimate origins or destinations of waterborne movements.

Source: Ferroalloy production from Iron Ore, Steel and Iron (Group VIII) Report. U.S. demand for manganese ore from U.S. Department of the Interior, Bureau of Mines, Mineral Commodity Profile: Manganese, 1977. U.S. ferroalloy production from American Iron and Steel Institute, Annual Statistical Report, 1976 ed., Table 33.

Table 6. Ohio River Basin: Consumption of Sulfur by BEAs or BEA Segments,[a] Estimated 1969-76

(Thousands of tons)

BEA and BEA segment	1969	1970	1971	1972	1973	1974	1975	1976
Primary Study Areas	468.8	474.9	470.2	469.1	503.1	538.0	544.1	584.9
BEA 47: Huntsville, AL	36.5	38.2	39.5	39.1	43.4	53.2	52.9	60.8
BEA 48: Chattanooga, TN	25.3	23.6	24.0	24.2	24.7	25.7	24.2	26.5
BEA 49: Nashville, TN	21.4	20.5	19.6	19.7	20.2	21.2	20.1	22.1
BEA 50: Knoxville, TN	6.7	6.5	6.9	10.0	13.2	16.7	18.3	22.7
BEA 52: Huntington, W[illegible]	113.8	115.4	110.3	111.4	101.0	106.5	98.4	97.9
BEA 54: Louisvi[illegible]	67.3	66.3	62.7	61.6	65.0	72.6	70.4	75.0
BEA 55: Eva[illegible]	10.3	11.0	11.3	12.5	14.4	2.1	17.5	18.8
BEA 62: Cincinn[illegible]	65.4	68.5	68.1	69.2	72.2	72.3	72.1	75.7
BEA 64: Columbus, [illegible]	51.2	52.5	55.3	60.7	61.5	68.0	68.8	74.0
BEA 65: Clarksburg, WV	4.0	3.7	3.4	3.5	3.2	3.4	3.2	3.2
BEA 66: Pittsburgh, PA	45.9	47.4	48.3	55.2	59.3	67.3	67.1	72.3
BEA 68: Cleveland, OH	0.7	0.7	0.7	0.7	0.8	0.8	0.9	1.0
BEA 115: Paducah, KY	20.3	20.6	20.1	21.3	24.2	28.2	30.2	34.9

Note: A factor relating consumption of sulfur to the production of sulfuric acid was calculated on a national basis. This factor of .335 tons of sulfur consumed per ton of sulfuric acid produced, in conjunction with another factor representing the percentage share by weight of sulfuric acid production of total U.S. chemical production. In 1974, sulfuric acid accounted for 17.5 percent of total U.S. chemical production. Combining these two relationships, a factor of 0.588 was derived and applied to RRNA's estimates of chemical production by BEA or BEA segment.

a. BEA segments defined as counties which are ultimate origins or destinations of waterborne movements.

Source: Chemical production by BEA or BEA segment from Chemicals and Chemical Fertilizers (Group VI) Report. U.S. sulfur consumption from U.S. Department of the Interior, Bureau of Mines, "Sulfur," Mineral Facts and Problems, 1975 ed., U.S. sulfuric acid and total chemical production from the American Chemical Society, "Facts and Figures for the Chemical Industry," Chemical and Engineering News, June 12, 1978.

tons by 1976 (Table 7). The largest consuming areas of rock salt in the PSAs were BEA 66 (Pittsburgh), BEA 62 (Cincinnati), and BEA 64 (Columbus). In 1976, these BEAs, collectively, accounted for about 50 percent of total consumption in the PSAs.

D-4. Zinc Ore and Concentrates

There were two PSAs that consumed zinc ore and concentrates during 1969-76. These were BEA 66 (Pittsburgh) and BEA 65 (Clarksburg). In the Pittsburgh area, there were two major zinc smelters operating during the period -- St. Joe Mineral Corp. at Monaca, PA, and the New Jersey Zinc facility at Palmerton, PA.

The consumption of zinc ore and concentrates in the PSAs was estimated at 667 thousand tons in 1969 and 464 thousand tons in 1976 (Table 8). The consumption of zinc ore is directly related to the zinc metal production in the PSAs.

D-5. Alumina Ore and Concentrates

The consumption of alumina ore and concentrate in the PSAs increased by an average annual rate of 5.4 percent during the 1969-76 period (Table 9). In 1969, alumina ore consumption in the PSAs totaled over 2.2 million tons. It increased to over 3.4 million tons by 1976.

The largest consuming PSA of alumina ore and concentrates was BEA 55 (Evansville). This BEA consumed over 1 million tons of alumina ore and concentrate in 1976. Other BEAs which consume significant amounts of alumina are BEA 47 (Hunstville), BEA 50 (Knoxville), and BEA 66 (Pittsburgh).

E. Forecasting Procedures and Assumptions

Projections for the ore and mineral commodities were based, primarily, upon projections of production of other commodities in this study. This methodology results from the nature of demand for ores and minerals. This demand, of course, is a derived demand, determined by the production levels of products for which they are either primary or intermediate inputs.

Future manganese ore and concentrates demand was projected using steel and ferroalloy production projections provided by the Iron Ore, Steel and Iron (Group VIII) Report. Steel production in

Table 7. Ohio River Basin: Consumption of Rock Salt, by BEAs or BEA Segments,[a] Estimated 1969-76

(Thousands of tons)

BEA and BEA segment	1969	1970	1971	1972	1973	1974	1975	1976
Primary Study Areas	928.6	1,079.2	1,071.5	1,246.8	819.7	1,057.8	1,061.1	1,232.9
BEA 48: Chattanooga, TN	48.5	56.3	55.9	65.1	42.8	55.2	55.4	64.3
BEA 49: Nashville, TN	93.6	108.7	108.0	125.6	82.6	106.6	106.9	124.2
BEA 50: Knoxville, TN	58.4	67.8	67.3	78.3	51.5	66.5	66.7	77.5
BEA 52: Huntington, WV	79.2	92.1	91.4	106.4	69.9	90.3	90.5	105.2
BEA 54: Louisville, KY	79.6	92.6	91.9	106.9	70.3	90.7	91.0	105.7
BEA 55: Evansville, IN	49.9	58.0	57.6	67.0	44.1	56.9	57.0	66.3
BEA 62: Cincinnati, OH	120.2	139.7	138.7	161.4	106.1	136.9	137.3	159.6
BEA 64: Columbus, OH	116.7	135.6	134.7	156.7	103.0	132.9	133.4	155.0
BEA 65: Clarksburg, WV	[illegible]	24.1	23.9	27.9	18.3	23.6	23.7	27.5
BEA 66: Pittsburgh, PA	226.3	263.1	261.2	303.9	199.8	257.8	258.6	300.5
BEA 115: Paducah, KY	35.5	41.2	40.9	47.6	31.3	40.4	40.6	47.1

Note: Consumption of rock salt for highway use by individual state highway departments was obtained from the Salt Institute, Survey of Salt, Calcium Chloride, and Abrasive Use in the United States and Canada for 1973-74. The states in the ORB consumed 43.3 percent of the total rock salt consumed by all U.S. state highway departments for that year. This percentage was then applied to the total rock salt consumed for highway and governmental use, as reported by the Bureau of Mines, to obtain total rock salt consumed for highway use in the Primary Study Areas. This total was then allocated to BEAs and BEA segments utilizing population data from OBERS.

a. BEA segments defined as counties which are ultimate origins or destinations of waterborne movements.

Source: Consumption of rock salt for highway use by state highway departments from Salt Institute, Survey of Salt, Calcium Chloride and Abrasive Use in the United States and Canada for 1973-74. U.S. rock salt consumption from U.S. Department of the Interior. Bureau of Mines, "Salt," Minerals Yearbook, 1969-76 eds. Population data supplied by the U.S. Department of Commerce, Bureau of Economic Analysis.

Table 8. Ohio River Basin: Consumption of Zinc Ore and Concentrate, by BEAs or BEA Segments,[a] Estimated 1969-76

(Thousands of tons)

BEA and BEA segment	1969	1970	1971	1972	1973	1974	1975	1976
Primary Study Areas	666.6	557.6	487.4	443.9	398.7	398.2	344.6	464.2
BEA 65: Clarksburg, WV	--	--	--	--	--	6.3	11.9	18.2
BEA 66: Pittsburgh, PA	666.6	557.6	487.4	443.9	398.7	391.9	332.7	446.0

Note: A factor representing zinc ore consumed per ton of primary zinc produced on a national basis was derived from U.S. Department of the Interior, Bureau of Mines. This factor of 2.33 tons of zinc ore per ton of primary zinc produced was then applied to RRNA estimates of ORB primary zinc production by BEA or BEA segment.

a. BEA segments defined as counties which are ultimate origins or destinations of waterborne movements.

Source: U.S. Department of the Interior, Bureau of Mines, "Zinc," Minerals Yearbook, 1976 ed. Primary zinc production by BEA or BEA segment from Nonferrous Metals and Alloys, Nec., (Group XIII) Report.

Table 9. Ohio River Basin: Consumption of Alumina Ores and Concentrates, by BEAs or BEA Segments[a], Estimated 1969-76

(Thousands of tons)

BEA and BEA segment	1969	1970	1971	1972	1973	1974	1975	1976
Primary Study Areas	2,241.6	2,349.8	2,319.4	2,435.6	2,676.4	3,251.2	2,859.8	3,408.6
BEA 47: Huntsville, AL	461.3	483.6	477.3	501.2	550.8	614.8	501.2	557.3
BEA 48: Chattanooga, TN	--	--	--	--	--	93.1	147.4	234.3
BEA 49: Nashville, TN	144.2	151.1	149.2	156.6	172.1	214.3	191.7	234.3
BEA 50: Knoxville, TN	461.3	483.6	477.3	501.2	550.8	614.8	501.2	557.3
BEA 52: Huntington, WV	201.8	211.5	208.8	219.3	240.9	260.9	213.8	234.3
BEA 55: Evansville, IN	511.7	536.4	529.5	556.1	611.0	838.5	803.3	1,033.8
BEA 66: Pittsburgh, PA	461.3	483.6	477.3	501.2	550.8	614.8	501.2	557.3

Note: Consumption of alumina ores and concentrates were estimated by applying a factor of 1.9 tons of ore consumed per ton of aluminum metal produced to RRNA estimates of aluminum production by BEA or BEA segment as reported in the Nonferrous Metals and Alloys (Group XIII) Report of this study. The factor of 1.9 was obtained from national statistics published by the U.S. Bureau of Mines.

a. BEA segments defined as counties which are ultimate origins or destinations of waterborne movements.

Source: U.S. Department of Commerce, Bureau of Economic Analysis, Survey of Current Business, 1972-78, and the Aluminum Association, Aluminum Statistical Review, 1977 ed., U.S. Department of the Interior, Bureau of Mines, Mineral Commodity Profile: Aluminum, 1978 ed.; Mineral Facts and Problems, 1975 ed. Aluminum metal production by BEA or BEA segment from Nonferrous Metals (Group XIII) Report of this study.

the PSAs was projected to increase at an average annual rate of 0.9 percent for the forecast period of 1976-2040. This proved to be acceptable as a general basis for projection of managanese consumption due to the direct relationship between the use of manganese and the production of steel. As mentioned earlier, in the United States, manganese has traditionally been consumed at the rate of 14 pounds per ton of raw steel produced. However, given the present trend toward lower consumption rates for manganese in steelmaking, the consumption of manganese per ton of steel produced was projected to decrease by 10 percent between 1976 and 1990 and to remain stable thereafter.

Sulfur consumption was projected using chemical and fertilizer production projections provided by the Chemicals and Chemical Fertilizers (Group VI) Report. The average annual growth rate for industrial and agricultural chemical production in the PSAs was estimated at 3.8 percent for the period 1976-2000 and at 3.0 percent for the period 2000-2040. It was assumed that sulfuric acid would continue to account for approximately 17.5 percent of the chemical production in the PSAs.

Future demand for salt for deicing purposes was projected according to estimates obtained from industry sources. Industry officials, while considering the slower growth of national highway construction and environmental concerns, project that the consumption of salt for highway deicing in the United States will increase to a level of 13 million tons by 2000. After 2000, however, growth in consumption of salt is projected to be negligible. These estimates for the U.S. consumption of rock salt for deicing purposes were disaggregated into PSAs in accordance with their levels of consumption during 1976.

Projections for the production of zinc metal in the PSAs were included as a component of the projections of Nonferrous Metals and Alloys (Group XIII). The projections for zinc metal production were then used in determining future requirements of zinc ore and concentrates. A factor of 2.33 tons of zinc ore and concentrates (gross weight) per ton of primary zinc produced was applied to the projections of primary zinc production. This factor takes into account losses resulting from the milling and smelting of virgin ore into primary zinc metal.

Future consumption of alumina ore and concentrates was projected using forecasts of aluminum metal production, which is another component of the projections of Nonferrous Metals and

Alloys (Group XIII). A factor representing the amount of alumina ore consumed per ton of aluminum metal produced was derived on a national basis and applied to the aluminum metal production forecast for individual BEA and BEA segments.

F. Probable Future Demand

The consumption of ores and minerals in the PSAs is projected to increase at an average annual rate of 4.4 percent between 1976 and 2000 and at a lower average annual rate (2.2 percent) for the period of 2000 through 2040 (Table 10).

The growth in ores and minerals consumption in the PSAs is primarily due to the increased demand for alumina. Alumina consumption is projected to increase at an annual average rate of 5.9 percent through 2000. Projections for consumption of manganese ore, sulfur, rock salt, zinc ore, and alumina ore are presented in Tables 11, 12, 13, 14, and 15, respectively. For the period 1976 through 2000, manganese ore and sulfur consumption levels are expected to grow at average annual rates of 1.3 and 3.8 percent. After 2000, the growth in ores and minerals consumption will be slower due primarily to the stabilization in demand for aluminum and rock salt. For the period of 2000-2040, the consumption of alumina is projected to grow at an average annual rate of 2.2 percent. Rock salt is projected to increase at an average annual rate of only 0.5 percent after 2000 as new highway construction in the PSAs for that period is expected to be negligible.

Table 10. Ohio River Basin: Consumption of Ores and Minerals,[a] by BEAs or BEA Segments,[b] Estimated 1976 and Projected 1980-2040, Selected Years

(Thousands of tons unless otherwise specified)

BEA and BEA segment	Estimated 1976	Projected 1980	1990	2000	2020	2040	Average annual percentage change 1976-2000	2000-2040
Primary Study Areas	6,720.2	8,289.3	13,503.2	18,987.9	33,076.4	45,664.3	4.4	2.2
BEA 47: Huntsville, AL	618.1	793.3	1,492.9	2,215.3	4,085.2	5,796.2	5.5	2.4
BEA 48: Chattanooga, TN	345.8	403.9	712.3	1,020.4	1,804.6	2,491.2	4.6	2.3
BEA 49: Nashville, TN	380.6	494.1	953.7	1,407.3	2,585.4	3,580.0	5.6	2.4
BEA 50: Knoxville, TN	657.5	831.0	1,398.5	1,957.2	3,361.7	4,470.0	4.7	2.1
BEA 52: Huntington, WV	437.4	544.6	809.7	1,076.9	1,731.8	2,471.3	3.8	2.1
BEA 54: Louisville, KY	180.7	212.0	285.3	358.9	523.1	784.8	2.9	2.0
BEA 55: Evansville, IN	1,118.9	1,709.9	3,916.2	6,212.0	12,347.8	17,515.1	7.4	2.6
BEA 62: Cincinnati, OH	235.3	276.2	377.1	473.5	685.2	1,029.9	3.0	2.0
BEA 64: Columbus, OH	500.4	549.3	653.0	801.5	1,159.2	1,590.5	2.0	1.7
BEA 65: Clarksburgh, WV	48.9	55.6	70.0	80.7	99.6	122.1	2.1	1.0
BEA 66: Pittsburgh, PA	1,916.8	2,094.8	2,418.5	2,851.4	3,887.9	4,754.3	1.7	1.3
BEA 68: Cleveland, OH	1.0	1.1	1.5	2.0	3.3	5.7	2.9	2.7
BEA 115: Paducah, KY	278.8	323.5	414.5	530.8	801.6	1,053.2	2.7	1.7

a. Includes consumption of manganese, liquid sulfur, rock salt, zinc ore and alumina.
b. BEA segments defined as counties which are ultimate origins or destinations of waterborne movements.
Source: Consumption of manganese, liquid sulfur, rock salt, zinc ore and alumina from Tables 11-15, respectively.

Table 11. Ohio River Basin: Consumption of Manganese Ore, by BEAs or BEA Segments,[a] Estimated 1976 and Projected 1980-2040

(Thousands of tons unless otherwise specified)

BEA or BEA segment	Estimated 1976	Projected 1980	1990	2000	2020	2040	Average annual percentage change 1976-2000	2000-2040
Primary Study Areas	1,029.6	1,085.3	1,145.6	1,385.1	2,021.0	2,445.3	1.3	1.4
BEA 48: Chattanooga, TN	20.7	21.5	26.8	36.0	60.4	78.4	2.3	2.0
BEA 64: Columbus, OH	271.4	282.0	288.5	344.3	499.2	601.7	1.0	1.4
BEA 66: Pittsburgh, PA	540.7	551.0	540.7	631.2	888.6	1,055.1	0.6	1.3
BEA 115: Paducah, KY	196.8	230.8	289.6	373.6	572.8	710.1	2.7	1.6

Note: A factor representing the quantity of manganese ore consumed per ton of ferroalloys produced was derived on a national basis and applied to RRNA's estimates of ferroalloy production for Ohio River Basin BEA segments. For 1976, the factor of .652 tons of manganese ore per ton of ferroalloy was used. The Bureau of Mines projects that consumption of manganese ore per ton of steel, and consequently ferroalloys produced, will decline 10 percent per ton of steel between 1974 and 1985 This was taken into account by reducing the factor of .652 in 1976 by 5 percent for 1980, and an additional 10 percent for 1990. Thus for 1980, a factor of .619 tons of manganese ore per ton of ferroalloy produced was used and for 1990 through 2040, a factor of .557 was applied.

a. BEA segments defined as counties which are ultimate origins or destinations of waterborne movements.

Source: 1976 data from Table 5. Projections of ferroalloy production from Iron Ore, Steel and Iron (Group VIII) Report. Manganese consumption trends in ferroalloy production from U.S. Department of the Interior, Bureau of Mines, "Ferroalloys," Mineral Facts and Problems, 1975 ed.

Table 12. Ohio River Basin: Consumption of Sulfur by BEAs or BEA Segments,[a] Estimated 1976 and Projected 1980-2040

(Thousands of tons unless otherwise specified)

BEA and BEA segment	Estimated 1976	Projected 1980	Projected 1990	Projected 2000	Projected 2020	Projected 2040	Average annual percentage change 1976-2000	Average annual percentage change 2000-2040
Primary Study Areas	584.9	707.8	1,004.4	1,424.1	2,568.0	4,652.1	3.8	3.0
BEA 47: Huntsville, AL	60.8	75.3	126.0	195.8	395.0	796.6	5.0	3.6
BEA 48: Chattanooga, TN	26.5	34.3	51.8	75.9	142.0	265.6	4.5	3.2
BEA 49: Nashville, TN	22.1	25.0	32.1	42.8	71.1	118.1	2.8	2.6
BEA 50: Knoxville, TN	22.7	23.7	34.4	49.1	89.0	161.3	3.3	3.0
BEA 52: Huntington, WV	97.9	121.6	147.5	190.1	302.5	481.4	2.8	2.3
BEA 54: Louisville, KY	75.0	91.2	128.3	180.2	319.7	567.5	3.7	2.9
BEA 55: Evansville, IN	18.8	22.5	30.3	41.4	71.4	123.2	3.3	2.8
BEA 62: Cincinnati, OH	75.7	93.9	140.1	203.8	378.3	702.0	4.2	3.1
BEA 64: Columbus, OH	74.0	90.3	134.4	195.4	361.9	670.4	4.1	3.1
BEA 65: Clarksburg, WV	3.2	4.4	6.3	8.9	16.3	29.7	4.3	3.1
BEA 66: Pittsburgh, PA	72.3	85.6	116.7	161.1	279.3	484.3	3.4	2.8
BEA 68: Cleveland, OH	1.0	1.1	1.5	2.0	3.3	5.7	3.0	2.7
BEA 115: Paducah, KY	34.9	38.9	55.0	77.6	138.2	246.3	3.4	2.9

Note: A factor relating consumption of sulfur to production of sulfuric acid was calculated on a national basis. This factor of .335 tons of sulfur consumed per ton of sulfuric acid produced, in conjunction with another factor representing the percentage share by weight of sulfuric acid production of total U.S. chemical production. In 1974, sulfuric acid accounted for 17.5 percent of total U.S. chemical production. Combining these two relationships, a factor of 0.588 was derived and applied to RRNA's estimates of chemical production by BEA or BEA segment.

a. BEA segments defined as counties which are ultimate origins or destinations of waterborne movements.

Source: Chemical production by BEA or BEA segment from Chemicals and Chemical Fertilizers (Group VI) Report. U.S. sulfur consumption from U.S. Department of the Interior, Bureau of Mines, "Sulfur," Mineral Facts and Problems, 1975 ed., U.S. sulfuric acid and total chemical production from the American Chemical Society, "Facts and Figures for the Chemical Industry," Chemical and Engineering News, June 12, 1978.

Table 13. Ohio River Basin: Consumption of Rock Salt, by BEAs or BEA Segments[a], Estimated 1976 and Projected 1980-2040

(Thousands of tons unless otherwise specified)

BEA or BEA segment	Estimated 1976	Projected 1980	1990	2000	2020	2040	Average annual percentage change 1976-2000	2000-2040
Primary Study Areas	1,232.9	1,408.5	1,830.9	2,083.4	2,371.5	2,533.6	2.2	0.5
BEA 48: Chattanooga, TN	64.3	73.5	95.5	108.7	123.7	132.2	2.2	0.5
BEA 49: Nashville, TN	124.2	141.9	184.5	209.9	238.9	255.3	2.2	0.5
BEA 50: Knoxville, TN	77.5	88.5	115.1	130.9	149.0	159.2	2.2	0.5
BEA 52: Huntington, WV	105 2	120.2	156.2	177.8	202.4	216.2	2.2	0.5
BEA 54: Louisville, KY	105.7	120.8	157.0	178.7	203.4	217.3	2.2	0.5
BEA 55: Evansville, IN	66.3	75.7	98.4	112.0	127.5	136.2	2.2	0.5
BEA 62: Cincinnati, OH	159.6	182.3	237.0	269.7	306.9	327.9	2.2	0.5
BEA 64: Columbus, OH	155.0	177.0	230.1	261.8	298.1	318.4	2.2	0.5
BEA 65: Clarksburg, WV	27.5	31.5	40.9	46.5	53.0	56.6	2.2	0.5
BEA 66: Pittsburgh, PA	300.5	343.3	446.3	507.8	578.0	617.5	2.2	0.5
BEA 115: Paducah, KY	47.1	53.8	69.9	79.6	90.6	96.8	2.2	0.5

Note: Consumption of rock salt for 1976 was estimated by RRNA as shown in Table 7. From conversation with industry sources, U.S. consumption of rock for highway use was projected to increase from 8.8 million tons in 1976 to 10 million tons in 1980. By 1990, U.S. consumption of rock salt was projected to reach 13 million tons. The Primary Study Areas were assumed to maintain, in total, a 20.3 percent share of the U.S. total rock salt consumed for highway use. The total of the PSAs was allocated to BEAs or BEA segments according to the consumption distribution prevailing in 1976.

a. BEA segments defined as counties which are ultimate origins or destinations of waterborne movements.

Source: Consumption of rock salt for 1976 from Table 7. Growth rates based on interviews with industry officials and U.S. Department of the Interior, Bureau of Mines, "Salt," Minerals Facts and Problems, 1975 ed.

Table 14. Ohio River Basin: Consumption of Zinc Ore and Concentrate, by BEAs or BEA Segments,[a] Estimated 1976 and Projected 1980-2040

(Thousands of tons unless otherwise specified)

BEA and BEA segment	Estimated 1976	Projected 1980	Projected 1990	Projected 2000	Projected 2020	Projected 2040	Average annual percentage change 1976-2000	Average annual percentage change 2000-2040
Primary Study Areas	464.2	502.7	581.6	645.0	771.6	913.9	1.4	0.9
BEA 65: Clarksburg, WV	18.2	19.6	22.8	25.3	30.3	35.8	1.4	0.9
BEA 66: Pittsburgh, PA	446.0	483.0	558.8	619.7	741.3	878.1	1.4	0.9

Note: A factor representing zinc ore consumed per ton of primary zinc produced on a national basis was derived from the U.S. Department of the Interior, Bureau of Mines. This factor of 2.33 tons of zinc ore per ton of primary zinc produced was then applied to RRNA's estimates of ORB primary zinc production by BEAs or BEA segments.

a. BEA segments defined as counties which are ultimate origins or destinations of water-borne movements.

Source: 1976 data from Table 8. U.S. Department of the Interior, Bureau of Mines, "Zinc," Minerals Yearbook, 1976 ed. Growth rates derived from projections of primary zinc production obtained from Nonferrous Metals and Alloys, Nec., (Group XIII) Report.

Table 15. Ohio River Basin: Consumption of Alumina Ores and Concentrates, By BEAs or BEA Segments[a], Estimated 1976 and Projected 1980-2040, Selected Years

(Thousands of tons unless otherwise specified)

BEA and BEA Segment	Estimated 1976	Projected 1980	Projected 1990	Projected 2000	Projected 2020	Projected 2040	Average annual percentage change 1976-2000	Average annual percentage change 2000-2040
Primary Study Areas	3,408.6	4,585.0	8,940.7	13,450.3	25,344.3	35,119.4	5.89	2.43
BEA 47: Huntsville, AL	557.3	718.0	1,366.9	2,019.5	3,690.2	4,999.6	5.51	2.29
BEA 48: Chattanooga, TN	234.3	274.6	538.2	799.8	1,478.5	2,015.0	5.25	2.34
BEA 49: Nashville, TN	234.3	327.2	737.1	1,154.6	2,275.4	3,206.6	6.87	2.59
BEA 50: Knoxville, TN	557.3	718.8	1,249.0	1,777.2	3,123.7	4,149.5	4.95	2.14
BEA 52: Huntington, WV	234.3	302.8	506.0	709.0	1,226.9	1,773.7	4.72	2.32
BEA 55: Evansville, IN	1,033.8	1,611.7	3,787.5	6,058.6	12,148.9	17,255.7	7.65	2.65
BEA 66: Pittsburgh, PA	557.3	631.9	756.0	931.6	1,400.7	1,719.3	2.16	1.54

Note: Consumption of alumina ores and concentrates was projected by applying a factor of 1.9 tons of ore consumed per ton of aluminum metal produced to *RRNA* projections of aluminum production by BEA or BEA segment as shown in the Nonferrous Metals (Group XIII) Report of this study. The factor of 1.9 was obtained from national statistics published by the U.S. Bureau of Mines. Aluminum metal production by BEA or BEA segment from Nonferrous Metals (Group XIII) Report of this study.

a. BEA segments defined as counties which are ultimate origins or destinations of waterborne movements.

Sources: U.S. Water Resource Council, OBERS Projections, Regional Economic Activity in the U.S., Series E, 1972 ed.; U.S. Department of the Interior, Bureau of Mines, Mineral Commodity Profile: Aluminum, 1978 ed., and Mineral Facts and Problems, 1975 ed.; U.S. Department of Commerce, Bureau of Economic Analysis, Survey of Current Business, 1972-78, and The Aluminum Association, Aluminum Statistical Review, 1977 ed.

III. COMMODITY RESOURCE INVENTORY

There is little production of waterborne ores and minerals in the PSAs. However, due to industrial demands for these minerals, the PSAs are major importers of materials. One exception is zinc. It is mined in Tennessee.

Other commodities in Group VII, such as clay and gypsum, are mined extensively in the PSAs but have rarely been transported in the past via the waterway; nor are they expected to be moved by barge in significant quantities in the future. For this reason, these commodities were not included in our estimates of mining production in the PSAs.

A. Production Areas

The production of Group VII commodities in the PSAs is supplemented by production in Secondary Production Areas (SPAs) located outside the Ohio River Basin. These SPAs are defined as BEAs which are the origins of Group VII waterborne movements destined to the Ohio River Basin.

BEA 138 (Baton Rouge) is the most important SPA. It has large reserves of salt and sulfur, and it is a port of entry for significant foreign exports of manganese ore and concentrates to the United States.

B. Production Characteristics and Reserves

The production characteristics and reserves vary widely according to the particular ore or mineral being considered. The characteristics of each of the major ores and minerals that move in the ORS are individually discussed below.

B-1. Manganese

The United States does not possess any manganese ore reserves which contain 35 percent or more manganese. It must, therefore, import all of its required manganese. As shown in Table 16, U.S. imports of manganese ore declined during 1969-76 as greater and greater amounts of manganese were imported in either alloy or metal form. This trend is expected to continue as ore-rich nations such as Brazil and Gabon continue to process their ore prior to export.

B-2. Sulfur

The United States reserves of sulfur are estimated at 230 million tons.[1] Much of these reserves are located in the salt domes of the Gulf Coast sections of Louisiana and Texas. This sulfur is recovered through an economical procedure known as the Frasch process. During this process, hot water is injected through wells into underlying sulfur deposits. The water melts the sulfur which then returns to the surface as molten elemental sulfur, under the pressure of compressed air.

B-3. Rock Salt

The salt which is destined for the ORS is mined along the coastline of Louisiana and Texas. There are virtually unlimited supplies of salt worldwide, but available U.S. reserves have been estimated at 61 trillion tons.

B-4. Zinc Ore and Concentrates

The United States reserves of zinc are estimated at approximately 30 million tons (Table 17). The only state in the Ohio River Basin with any significant zinc reserves is Tennessee. That state has deposits in Smith and Jackson counties (central Tennessee); in Jefferson, Knox and Granger counties (northeast section of the state) and; in Polk County (southeast corner of the state).

B-5. Bauxite and Alumina Ore and Concentrates

There is no bauxite or alumina ore mined in the PSAs. In fact, with the exception of some production in Arkansas, the United

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1. U.S. Department of the Interior, Bureau of Mines, "Sulfur," Mineral Facts and Problems, 1975 ed. (Washington, D.C.: GPO, 1976).

Table 16. United States: Imports of Manganese Ore, Alloy and Metal,[a] Estimated 1969-76

(Thousands of tons unless otherwise specified)

	1969	1970	1971	1972	1973	1974	1975	1976	Average annual percentage change 1969-76
Manganese ore	992	847	938	793	722	593	766	649	(5.2)
Manganese alloy and metal	257	238	212	305	336	376	346	478	8.1
Total	1,249	1,085	1,150	1,098	1,058	969	1,127	1,127	(1.2)

a. Tonnages in terms of manganese content.

Source: U.S. Department of the Interior, Bureau of Mines, Mineral Commodity Profile: Manganese, 1977.

Table 17. United States: Zinc Ore Reserves by Districts, Estimated 1975[a]

(Millions of tons)

District	States	Reserves[b]
Northeastern	Maine, New Jersey, New York, Pennsylvania	4.0
South Appalachian	East Tennessee, Virginia	8.0
Mississippi Valley	Illinois, Missouri, Mid-Tennessee, Wisconsin	13.2
Northwestern	Idaho, Montana, Washington	2.0
Southwestern	Arizona, California, Colorado New Mexico, Utah	2.8
Total		30.0

a. Tonnages in terms of zinc content.
b. Reserves are limited to proven mining districts and to deposits that could be mined economically at current prices.
Source: U.S. Department of the Interior, Bureau of Mines, "Zinc," <u>Mineral Facts and Problems</u>, 1975 ed.

States imports its total bauxite and alumina requirements. Most of the bauxite imports originate in Jamaica, Guinea, and Surinam. Most of our alumina imports traditionally come from Australia and Jamaica. Total world bauxite reserves were estimated by the Bureau of Mines to be 25,000 million tons.

C. Existing Production Levels

Of the commodities in Group VII which registered significant waterway movements, zinc was the only one produced in measurable quantities in the PSAs. In 1969, zinc ore production in the PSAs was 124 thousand tons. BEA 50 (Knoxville) accounted for 88 thousand tons or 71 percent of the total PSA zinc production that year (Table 18). During the 1969-76 period, production of zinc declined in the BEA and total PSA production had dropped to 82 thousand tons by 1976.

It should be noted that other commodities in Group VII which are not transported within the ORS, such as clay and gypsum, are produced in significant amounts in many of the PSAs. However, since the production of these commodities has not and will not result in waterway movements, they were not included in the estimates of PSA ore and mineral production.

D. Forecasting Procedures and Assumptions

Projections for future production of zinc in the PSAs were based on U.S. Bureau of Mines (BOM) forecasts of probable U.S. mine production of zinc in the future.[1] The BOM methodology was based on a projection of the ratio of domestic zinc mine production to domestic primary zinc consumption which was applied to the probable demand in 2000. This ratio in recent years has been approximately 37 percent.

Bureau of Mines projections of probable demand for zinc were estimated from the projected demand of the individual end-use markets. Regression analyses were based on historical trends, on various economic indicators such as Gross National Product and Federal Reserve Board indexes, and on projection of the economic indicators. The results of the above projections were further modified, by different contingency assumptions regarding technology

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1. U.S. Department of the Interior, Bureau of Mines, "Zinc," Mineral Facts and Problems, 1975 ed. (Washington, D.C.: GPO, 1977).

Table 18. Ohio River Basin: Production of Zinc Ore, by BEAs or BEA Segments,[a] Estimated 1969-76

(Thousands of tons)

BEA or BEA segment	1969	1970	1971	1972	1973	1974	1975	1976
Primary Study Areas	124.5	118.3	119.3	101.7	64.2	85.7	83.0	82.5
BEA 48: Chattanooga, TN	8.6	8.2	8.2	7.0	4.4	5.9	5.7	5.7
BEA 49: Nashville, TN	27.8	26.4	26.6	22.7	14.3	19.1	18.5	18.4
BEA 50: Knoxville, TN	88.1	83.7	84.5	72.0	45.5	60.7	58.8	58.4

Note: Zinc ore production for Tennessee was obtained from the Bureau of Mines, Minerals Yearbook, 1969-76 eds. The state total was allocated to BEAs or BEA segments within the state utilizing county data for 1976 obtained from the Bureau of Mines, Tennessee liason office. This distribution was applied to the state total for each year.

a. BEA segments are counties which are ultimate origins or destinations of waterborne movements.

Source: U.S. Department of the Interior, Bureau of Mines, Minerals Yearbook, 1969-76 eds.

and other factors, to create a range of projections. A most probable level of demand was then established based on the knowledge and judgments of the commodity specialists of the Bureau of Mines.

National projections of production and/or consumption, as estimated by the Bureau of Mines, have been used for the purpose of estimating the production and/or consumption in the PSAs of the non-fuel nonferrous minerals analyzed in this study. For many minerals, the Bureau of Mines projections are the only available long-range projections (up to the year 2000) for tonnage. Even if other sources of projections could match the projection period and types of minerals included in the projections, it is unlikely that they could match the quality of BOM projections. Since 1967, the Bureau of Mines has developed and improved a methodology for the development of projections based on analyses of end use. Commodity specialists of the Bureau of Mines have access to an extensive data base which includes information such as size and location of reserves, production and prices. They are also in close contact with state and local authorities, researchers, and industry specialists.

For the projection of zinc ore production in the PSAs, the proportion of PSA zinc production to total U.S. production was maintained. Thus, for example, Tennessee production areas are expected to show growth in zinc production similar to that experienced by the Nation as a whole.

E. Probable Future Production Levels

Production of zinc ore in the PSAs is projected to grow at a 3.3 percent average annual rate for the 1976-2000 period and at a 2.6 percent rate for the period of 2000 through 2040 (Table 19). Thus, by the year 2000, zinc production in the PSAs is expected to reach 178 thousand tons a year. This is roughly double the production recorded for 1976 and is due to an expected increase in zinc consumption for galvanizing and industrial purposes, as well as more extensive zinc mining in Tennessee. Although the production of zinc ore will grow at a more moderate average annual rate (2.6 percent) between 2000 and 2040, annual zinc ore production in the PSAs is projected to reach 491 thousand tons by 2040.

Table 19. Ohio River Basin: Production of Zinc Ore, by BEAs or BEA Segments,[a] Estimated 1976 and Projected 1980-2040

(Thousands of tons unless otherwise specified)

BEA or BEA segments	Estimated 1976	Projected 1980	Projected 1990	Projected 2000	Projected 2020	Projected 2040	Average annual percentage change 1976-2000	Average annual percentage change 2000-2040
Primary Study Areas	82.5	88.8	119.3	178.6	296.1	490.9	3.3	2.6
BEA 48: Chattanooga, TN	5.7	6.1	8.2	12.3	20.4	33.8	3.3	2.6
BEA 49: Nashville, TN	18.4	19.8	26.6	39.8	66.0	109.4	3.3	2.6
BEA 50: Knoxville, TN	58.4	62.9	84.5	126.5	209.7	347.7	3.3	2.6

Note: Growth rates for U.S. mine production of zinc were obtained from the Bureau of Mines, Mineral Facts and Problems, 1975 ed., Table 9. These growth rates were then applied to the RRNA estimates of zinc ore production for 1976.

a. BEA segments defined as counties which are origins or destinations of waterborne movements.

Source: U.S. Department of the Interior, Bureau of Mines, Mineral Facts and Problems, 1975 ed. Production of zinc ore by BEA or BEA segment for 1976 from Table 18.

IV. TRANSPORTATION CHARACTERISTICS

Many of the commodities of Group VII originate in the Gulf Coast area either as foreign imports or from mineral deposits located in the Mississippi River delta. Due to the proximity of these domestic deposits to navigable waterways, it is often most convenient and cost-effective to ship the commodities to inland consuming areas by barge. This is especially the case when the consuming areas are also located near the waterway as the need for transshipments is thus eliminated.

A. Existing and Historical Modal Split

Ores and minerals are shipped into the consuming PSAs primarily via the Mississippi and Ohio River Systems. Most of the ferroalloy plants which receive imported manganese ore are located near the waterway; therefore, barge is the most convenient and least expensive transport mode. In addition, the chemical plants which consume the sulfur produced in the Gulf Coast area are also situated adjacent to the waterway. Table 20 presents the 1976 modal split by BEAs or BEA segments.

Rock salt, which is mined in the Gulf Coast area, is also usually shipped by barge to the large metropolitan consuming areas located in the ORS.

Significant quantities of ore and minerals are moved by rail and truck modes of transport in the PSAs. These consist primarily of local movements of clay and gypsum and receipts of some alumina and manganese.

B. Factors Affecting Modal Choice

For the most part, the proximities of the origin and destination points to the waterway determine which mode will be chosen

Table 20. Ohio River Basin: Production, Consumption and Shipments by Mode of Transportation of Ores and Minerals, BEAs or BEA Segments,[a] Estimated 1976

(Thousands of tons)

BEA and BEA segment	Production	Consumption	Shipments (receipts)						
			Total net	Water				Net rail	Net truck
				Net	Inbound	Outbound	Local		
Primary Study Areas	82.5	6,720.2	(6,637.7)	(3,580.0)	3,905.1[b]	325.1[b]	330.8[b]	(2,187.2)	(879.5)
BEA 47: Huntsville, AL	--	618.1	(618.1)	(121.0)	168.0	47.0	--	(11.0)	(486.1)
BEA 48: Chattanooga, TN	5.7	345.8	(340.1)	(152.4)	153.5	1.1	--	(185.4)	(2.3)
BEA 49: Nashville, TN	18.4	380.6	(362.2)	(94.5)	279.6	185.1	--	(144.1)	(123.6)
BEA 50: Knoxville, TN	58.4	657.5	(599.1)	(6.6)	6.6	--	--	(529.8)	(62.7)
BEA 52: Huntington, WV	--	437.4	(437.4)	(157.4)	228.6	71.2	--	(294.7)	14.7
BEA 54: Louisville, KY	--	180.7	(180.7)	(81.2)	81.2	--	--	(33.1)	(66.4)
BEA 55: Evansville, IN	--	1,118.9	(1,118.9)	(606.6)	659.7	53.1	--	7.8	(520.1)
BEA 62: Cincinnati, OH	--	235.3	(235.3)	(607.1)	607.1	--	--	(160.8)	595.6
BEA 64: Columbus, OH	--	500.4	(500.4)	(286.5)	313.9	27.4	--	(113.0)	(100.9)
BEA 65: Clarksburg, WV	--	48.9	(48.9)	(50.1)	50.1	--	--	(34.2)	35.4
BEA 66: Cleveland, OH	--	1.0	(1.0)	(108.0)	108.0	1.0	--	(11.8)	118.8
BEA 115: Paducah, KY	--	278.8	(278.8)	(557.2)	557.2	13.1	2.0	(15.2)	293.6

Note: Gross and net waterborne and net rail shipments (receipts) were determined for 1976 from U.S. Army Corps of Engineers waterborne commerce data and Interstate Commerce Commission railroad waybill data. Total net shipments (receipts) were determined by subtracting consumption from production. Net truck shipments (receipts) were determined by subtracting net waterborne and rail shipments (receipts) from total net shipments (receipts).

a. BEA segments defined as counties which are ultimate origins or destinations of waterborne movements.

b. Total Primary Study Area shipments equal inbound, outbound and local shipments for the PSAs as a unit and do not equal the sum of shipments reported from each of the BEAs and BEA segments.

Source: Estimated consumption and production from Tables 4 and 18. Water and rail shipments (receipts) compiled by RRNA from Waterborne Commerce by Port Equivalents, revised 1976, and ICC Railroad Waybill Sample, 1976, supplied by the U.S. Army Corps of Engineers.

to transport ores and minerals. When both the origin and destination are situated adjacent to a navigable waterway, the commodities are invariably shipped by barge. However, in instances where either the origin or destination is not located adjacent to the waterway, the commodities are generally transported by either rail or truck.

An exception is the receipt of rock salt in western North Carolina and Virginia. It originates as a barge shipment from the Gulf Coast to the Tennessee River amd is then transferred to trucks for transport into the consumption areas. The size of these transshipments is relatively small, however, and the consuming areas in North Carolina and Virginia were not analyzed separately.

C. Forecasting Procedures and Assumptions

Projections of modal split and waterborne shipments and receipts were based on 1976 transportation patterns. Waterborne receipts by PSA were assumed to increase at the same rate as consumption, and waterborne shipments were assumed to increase at the same rate as production. Net water shipments were obtained by subtracting receipts from shipments.

These projections of waterborne shipments and receipts were distributed among BEA-to-BEA links using historical distributions of shipments among BEA receivers (adjusted for projected changes in BEA shipments and receipts) and specific knowledge acquired by commodity specialists during the course of this study.

Net truck and net rail shipments were projected based on the assumption that net movements by these two modes would maintain a constant ratio to one another.

Assuming that there is no change in relative costs of transport modes, and that relative transport time will not change significantly, it is expected that the future modal split will not vary significantly from the 1976 splits for each BEA and BEA segment. The change in barge transportation for the PSAs as a whole, however, is captured by the different growth rates of production and consumption of each BEA and BEA segment in the area served by the ORS.

D. Probable Future Traffic Flows

The average annual growth rates of net waterborne ore and mineral commodity shipments are projected at 4.2 percent between

1976 and 2000 and at 2.2 percent between 2000 and 2040 (Table 21). These growth rates are due to inbound shipments which account for 87 percent of the total ore and mineral waterborne movements in the ORS. The total (gross) waterborne shipments of ores and minerals in the ORS is expected to reach 11,814.7 thousand tons in 2000, as compared to 4,451.0 thousand tons in 1976.

BEA-to-BEA waterborne traffic projections are presented in Table 22. Growth indices derived from the traffic projections are presented in Table 23.

Table 21. Ohio River Basin: Production, Consumption and Shipments by Mode of Transportation of Ores and Minerals, Estimated 1976 and Projected 1980-2040, Selected Years

(Thousands of tons unless otherwise specified)

	Estimated	Projected					Average annual percentage change	
	1976	1980	1990	2000	2020	2040	1976-2000	2000-2040
Production	82.5	88.8	119.3	178.6	296.1	490.9	3.3	2.6
Consumption	6,720.2	8,289.3	13,503.2	18,987.9	33,076.4	45,664.3	4.4	2.2
Net shipments (receipts)	(6,637.7)	(8,200.5)	(13,383.9)	(18,809.3)	(32,780.3)	(45,173.4)	4.4	2.2
Net waterborne	(3,580.0)	(4,399.4)	(6,975.5)	(9,644.8)	(16,490.7)	(22,917.3)	4.2	2.2
Net rail	(2,187.2)	(2,578.0)	(3,741.2)	(4,954.3)	(7,933.2)	(10,752.1)	3.5	2.0
Net truck	(870.5)	(1,223.1)	(2,667.2)	(4,210.2)	(8,356.4)	(11,504.0)	6.8	2.5
Gross waterborne shipments:								
Outbound	325.1	376.1	572.2	838.5	1,457.2	2,197.8	4.0	2.4
Inbound	3,905.1	4,775.5	7,547.7	10,483.3	17,947.9	25,115.1	4.2	2.2
Local	220.8	261.5	370.7	492.9	793.0	1,092.3	3.4	2.0
TOTAL	4,451.0	5,413.1	8,490.6	11,814.7	20,198.1	28,405.2	4.2	2.2

Note: Net shipments (receipts) equal to production minus consumption. Net waterway shipments were based on the projections of outbound and inbound shipments of the *individual* BEAs or BEA segments. Outbound water shipments for each BEA or BEA segment were based on the growth rates of production *in each* BEA. Inbound waterway shipments by BEA or BEA segment were projected based upon the growth of consumption in the individual BEAs. Local shipments were projected based upon the growth of the sum of production and consumption, which was used as a proxy of the activity level. Net inbound waterway movements for the Ohio River System were projected based on the projected waterway receipts of ORB BEAs or BEA segments and the historical proportion of those receipts which entered the ORS. Net outbound waterway movements were projected based upon the projected waterway *shipment* of ORB BEA and BEA segments and the historical proportion of those BEAs and BEA segments shipped to areas outside the *ORS*. Net truck and net rail shipments by BEA and BEA segments were assumed to have the same relationship to one another that existed in 1976.

Source: Tables 10, 19, and 20; *Waterborne Commerce by Port Equivalents*, 1969-76, supplied by the U.S. Army Corps of Engineers.

Table 22. Ohio River System: BEA-to-BEA
Waterborne Traffic of Ores and Minerals
Actual 1976 and Projected 1980-2040, Selected Years

			HUNDREDS OF TONS					
ORIGIN BEA	DESTINATION BEA	COMMODITY GROUP	1976	1980	1990	2000	2020	2040
038	066	07	33	36	42	50	68	83
047	115	07	470	603	975	1359	2404	3376
047	138	07	0	0	160	325	701	1029
048	114	07	11	12	16	23	38	63
049	091	07	170	183	246	368	610	1010
049	138	07	1500	1614	2168	3245	5381	8919
049	144	07	181	195	262	392	649	1077
052	055	07	45	76	289	442	916	1253
052	064	07	140	171	205	256	365	590
052	066	07	67	83	136	169	217	408
052	115	07	460	557	689	887	1323	1775
055	052	07	134	210	326	474	787	1016
055	066	07	31	32	35	40	60	80
055	068	07	33	47	99	157	326	490
055	077	07	207	316	724	1147	2282	3237
055	119	07	11	17	38	61	121	172
055	138	07	55	98	426	736	1622	2379
055	140	07	60	91	209	331	658	933
064	047	07	11	13	21	31	52	73
064	052	07	140	156	180	222	315	444
064	077	07	22	24	29	36	52	71
064	114	07	11	12	14	18	25	35
064	115	07	90	96	114	132	191	248
066	038	07	223	244	281	332	452	553
066	045	07	67	73	84	100	136	166
066	046	07	11	12	14	16	22	27
066	048	07	211	166	174	193	206	249
066	052	07	130	131	148	176	237	271
066	055	07	33	37	42	50	67	71
066	064	07	40	44	46	53	60	64
066	068	07	33	33	34	41	41	41
066	137	07	156	171	197	232	317	387
066	138	07	445	564	683	814	1199	1519
066	144	07	100	109	126	149	203	247
068	107	07	10	11	15	20	33	57
077	055	07	11	20	93	144	299	401
077	066	07	22	28	52	64	80	145
077	115	07	270	306	319	400	566	704
078	066	07	45	49	57	67	91	112
081	066	07	11	12	14	16	22	27
091	062	07	55	60	68	78	94	160
091	066	07	108	122	156	193	284	348

(Continued)

Table 22. (Continued)

ORIGIN BEA	DESTINATION BEA	COMMODITY GROUP	1976	1980	1990	2000	2020	2040
			HUNDREDS OF TONS					
113	052	07	10	13	19	25	40	57
114	062	07	89	103	127	161	239	358
114	064	07	11	14	30	36	46	67
115	052	07	120	138	172	223	331	426
115	115	07	20	22	22	24	32	48
115	138	07	11	15	30	40	71	97
137	049	07	768	1120	2570	4363	8750	12141
137	055	07	690	932	1488	2308	4084	5887
138	047	07	1669	2143	4036	5988	11049	15677
138	048	07	1324	1627	2988	4337	7805	10810
138	049	07	2028	2511	4437	5977	10245	14162
138	050	07	66	83	140	196	337	448
138	052	07	1674	2096	3236	4309	7022	10250
138	054	07	812	953	1283	1614	2352	3259
138	055	07	2527	3998	11020	15455	31181	44207
138	062	07	5719	6720	9190	11512	16568	24226
138	064	07	2948	3216	3815	4684	6801	9257
138	065	07	501	570	718	828	1022	1253
138	066	07	6255	6612	6730	7487	9013	11134
138	068	07	366	397	531	707	1151	2045
138	115	07	3983	4557	5747	7305	10858	14116
139	062	07	530	622	850	1067	1544	2320
140	062	07	89	105	143	179	260	390
141	066	07	178	197	235	281	395	502
141	068	07	22	22	23	28	40	66
143	055	07	3291	5019	10159	18229	36260	51455
143	066	07	43	58	69	110	151	175
144	052	07	78	102	150	198	317	449
144	062	07	197	231	333	413	591	1514
144	066	07	1540	1877	2988	3916	6517	7658
144	068	07	636	700	948	1247	2039	3571
915	062	07	22	26	31	75	221	368
915	115	07	430	498	642	786	1077	1349
		TOTAL	44510	54131	84906	118147	201981	284052

Note: BEA 915 refers to counties of BEA 115 which are origins of waterborne movements shipped from points on the Mississippi River.
Source: Robert R. Nathan Associates, Inc.

Table 23. Ohio River System: Growth Rates of Ores and Minerals Waterborne Commerce, BEA to BEA, Projected 1976-2040, Selected Years

BEA Pair[a]	Group No.	Index Value[b]	Year[c] 1976	1980	1990	2000	2020	2040
038066	07	33	1000	1091	1273	1515	2061	2515
047115	07	470	1000	1283	2074	2891	5115	7183
047138	07	160	0	0	1000	2031	4381	6431
048114	07	11	1000	1091	1455	2091	3455	5727
049091	07	170	1000	1076	1447	2165	3588	5941
049138	07	1500	1000	1076	1445	2163	3587	5946
049144	07	181	1000	1077	1448	2166	3586	5950
052055	07	45	1000	1689	6422	9822	20356	27844
052064	07	140	1000	1221	1464	1829	2607	4214
052066	07	67	1000	1239	2030	2522	3239	6090
052115	07	460	1000	1211	1498	1928	2876	3859
055052	07	134	1000	1567	2433	3537	5873	7582
055066	07	31	1000	1032	1129	1290	1935	2581
055068	07	33	1000	1424	3000	4758	9879	14848
055077	07	207	1000	1527	3498	5541	11024	15638
055119	07	11	1000	1545	3455	5545	11000	15636
055138	07	55	1000	1782	7745	13382	29491	43255
055140	07	60	1000	1517	3483	5517	10967	15550
064047	07	11	1000	1182	1909	2818	4727	6636
064052	07	140	1000	1114	1236	1586	2250	3171
064077	07	22	1000	1091	1318	1636	2364	3227
064114	07	11	1000	1091	1273	1636	2273	3182
064115	07	90	1000	1067	1267	1467	2122	2756
066038	07	223	1000	1094	1260	1489	2027	2480
066045	07	67	1000	1090	1254	1493	2030	2478
066046	07	11	1000	1091	1273	1455	2000	2455
066048	07	211	1000	787	825	915	976	1180
066052	07	130	1000	1008	1138	1354	1823	2085
066055	07	33	1000	1121	1273	1515	2030	2152
066064	07	40	1000	1100	1150	1325	1500	1500
066068	07	33	1000	1000	1030	1242	1242	1242
066137	07	156	1000	1096	1263	1487	2032	2481
066138	07	445	1000	1267	1535	1829	2694	3413
066144	07	100	1000	1090	1260	1490	2039	2470
068107	07	10	1000	1100	1500	2000	3300	5700
077055	07	11	1000	1818	8455	13091	27182	36455
077066	07	22	1000	1273	2364	2909	3636	6591
077115	07	270	1000	1133	1181	1481	2096	2607
078066	07	45	1000	1089	1267	1489	2022	2489
081066	07	11	1000	1091	1273	1455	2000	2455
091062	07	55	1000	1091	1236	1418	1709	2909
091066	07	108	1000	1130	1444	1787	2630	3222
113052	07	10	1000	1300	1900	2500	4000	5700
114062	07	89	1000	1157	1427	1809	2685	4022
114064	07	11	1000	1273	2727	3273	4182	6091

(Continued)

Table 23. (Continued)

BEA Pair[a]	Group No.	Index Value[b]	Year[c] 1976	1980	1990	2000	2020	2040
115052	07	120	1000	1150	1433	1858	2758	3550
115115	07	20	1000	1100	1100	1200	1600	2400
115138	07	11	1000	1364	2727	3636	6455	8818
137049	07	768	1000	1458	3346	5681	11393	15809
137055	07	690	1000	1351	2157	3345	5919	8532
138047	07	1669	1000	1284	2418	3588	6620	9393
138048	07	1324	1000	1229	2257	3276	5895	8165
138049	07	2028	1000	1238	2188	2947	5052	6983
138050	07	66	1000	1258	2121	2970	5106	6788
138052	07	1674	1000	1252	1933	2574	4195	6123
138054	07	812	1000	1174	1580	1988	2897	4014
138055	07	2527	1000	1582	4361	6116	12339	17494
138062	07	5719	1000	1175	1607	2013	2897	4236
138064	07	2948	1000	1091	1294	1589	2307	3140
138065	07	501	1000	1138	1433	1653	2040	2501
138066	07	6255	1000	1057	1076	1197	1441	1780
138068	07	366	1000	1085	1451	1932	3145	5587
138115	07	3983	1000	1144	1443	1834	2726	3544
139062	07	530	1000	1174	1604	2013	2913	4377
140062	07	89	1000	1180	1607	2011	2921	4382
141066	07	178	1000	1107	1320	1579	2219	2820
141068	07	22	1000	1000	1045	1273	1818	3000
143055	07	3291	1000	1525	3087	5539	11018	15635
143066	07	43	1000	1349	1605	2558	3512	4070
144052	07	78	1000	1308	1923	2538	4064	5756
144062	07	197	1000	1173	1690	2096	3000	7685
144066	07	1540	1000	1219	1940	2543	4232	4973
144068	07	636	1000	1101	1491	1961	3206	5615
915062[d]	07	22	1000	1182	1409	3409	10045	16727
915115[d]	07	430	1000	1158	1493	1828	2505	3137

a. The first three digits indicate the BEA of origin; the last three digits indicate the BEA of destination.

b. Hundreds of tons.

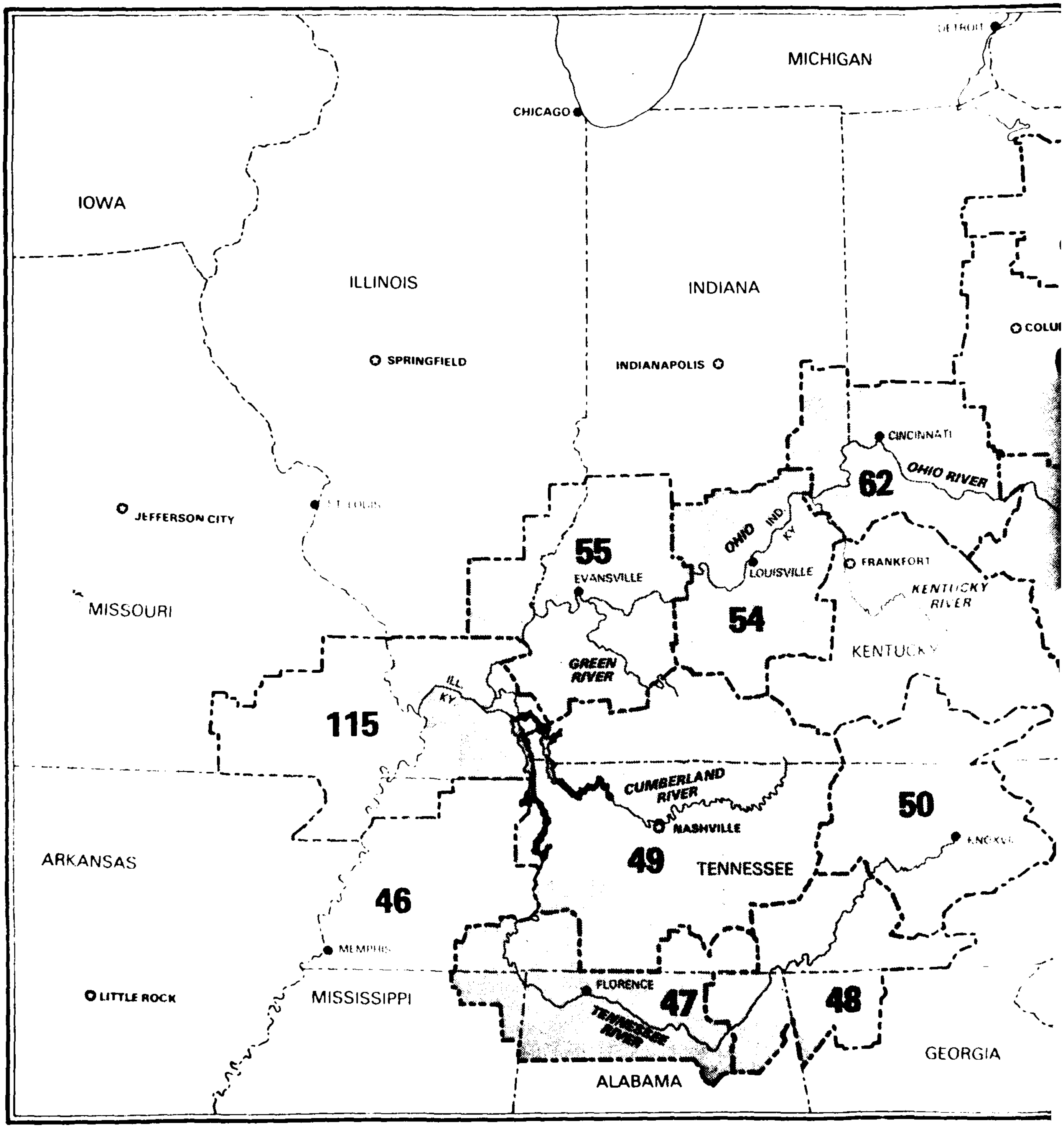
c. Growth rates are reported such that 1000 equals the index value reported in the third column.

d. BEA 915 refers to counties of BEA 115 which are origins of waterborne movements which are shipped from points on the Mississippi River.

Source: Robert R. Nathan Associates, Inc.

V. APPENDIX

MAP A-1. OHIO RIVER BASIN: PRIMARY ST DY AREAS FOR C
(BEAs AND BEA SEGMENTS)



SOURCE: Robert R. Nathan Associates, Inc.

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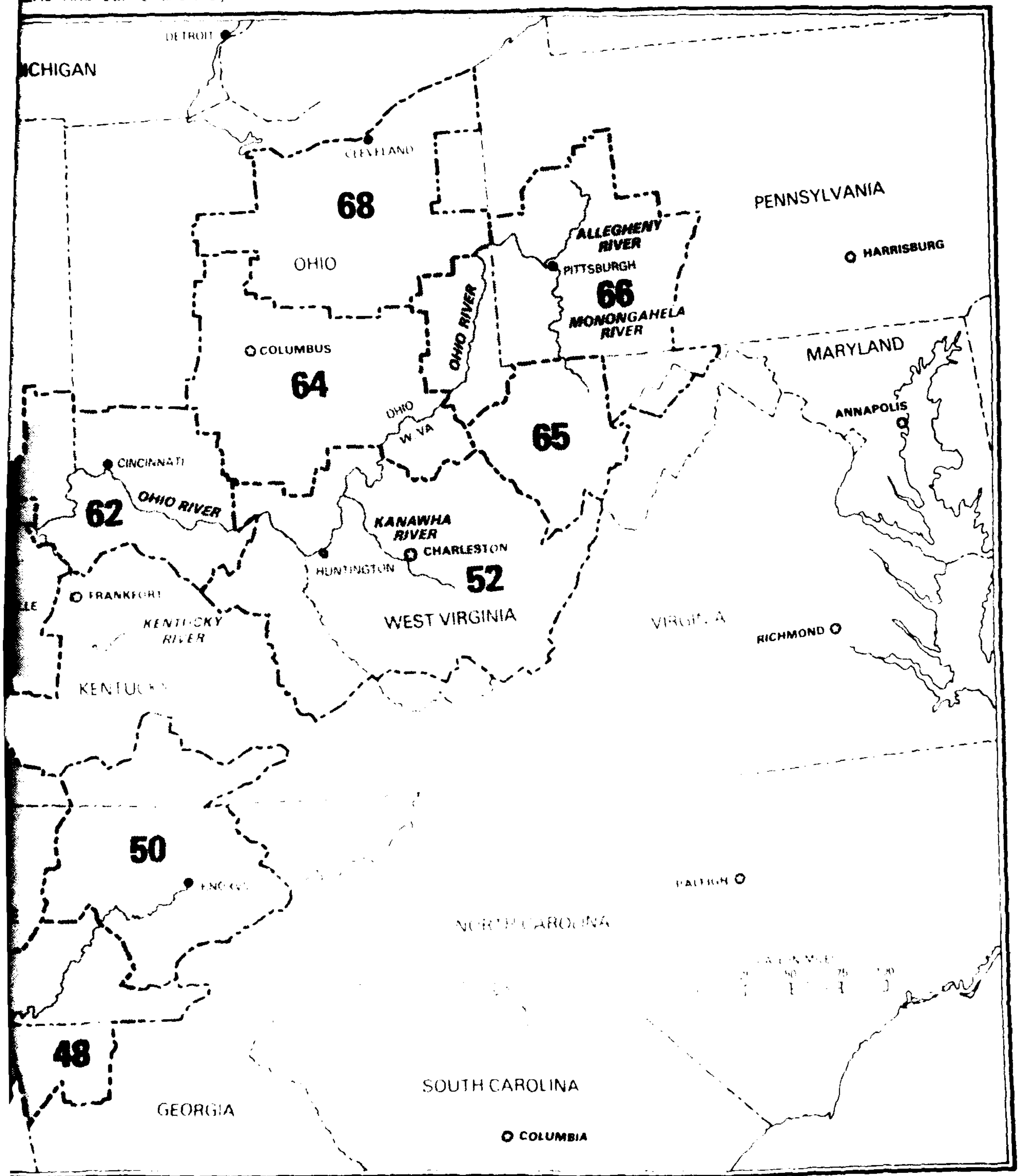
: PRIMARY STUDY AREAS FOR ORES AND MINERALS
EAs AND BEA SEGMENTS)



Primary Study Areas

Table A-1. Ohio River Basin: Primary Study Areas for Ores and Minerals (BEAs and BEA segments)

BEA 47: Huntsville, AL
- Colbert, AL
- Franklin, AL
- Lauderdale, AL
- Lawrence, AL
- Limestone, AL
- Madison, AL
- Marshall, AL
- Morgan, AL
- Alcorn, MS
- Tishomingo, MS
- Franklin, TN
- Hardin, TN
- Lincoln, TN
- McNairy, TN
- Wayne, TN

BEA 48 (segment): Chattanooga, TN
- DeKalb, AL
- Jackson, AL
- Catoosa, GA
- Chattooga, GA
- Dade, GA
- Walker, GA
- Whitfield, GA
- Bledsoe, TN
- Bradley, TN
- Grundy, TN
- Hamilton, TN
- Marion, TN
- McMinn, TN
- Meigs, TN
- Polk, TN
- Rhea, TN
- Sequatchie, TN

BEA 49 (segment): Nashville, TN
- Allen, KY
- Barren, KY
- Butler, KY
- Christian, KY
- Clinton, KY
- Cumberland, KY
- Edmonson, KY
- Logan, KY
- Metcalfe, KY
- Monroe, KY
- Simpson, KY
- Todd, KY
- Trigg, KY
- Warren, KY
- Benton, TN
- Cannon, TN
- Cheatham, TN
- Clay, TN
- Coffee, TN
- Davidson, TN
- DeKalb, TN
- Dickson, TN
- Giles, TN
- Hickman, TN
- Houston, TN
- Humphreys, TN
- Jackson, TN
- Lawrence, TN
- Lewis, TN
- Macon, TN
- Maury, TN
- Montgomery, TN
- Overton, TN
- Perry, TN
- Pickett, TN
- Putnam, TN
- Robertson, TN
- Rutherford, TN
- Smith, TN
- Stewart, TN
- Sumner, TN
- Trousdale, TN
- Van Buren, TN
- Warren, TN
- White, TN
- Williamson, TN
- Wilson, TN

BEA 50 (segment): Knoxville, TN
- Anderson, TN
- Blount, TN
- Campbell, TN
- Cumberland, TN
- Fentress, TN
- Grainger, TN
- Jefferson, TN
- Knox, TN
- Loudon, TN
- Monroe, TN
- Morgan, TN
- Roane, TN
- Scott, TN
- Sevier, TN
- Union, TN

(Continued)

Table A-1. (Continued)

BEA 52 (segment): Huntington, WV
- Boyd, KY
- Carter, KY
- Elliot, KY
- Greenup, KY
- Lawrence, KY
- Rowan, KY
- Gallia, OH
- Lawrence, OH
- Meigs, OH
- Scioto, OH
- Boone, WV
- Cabell, WV
- Clay, WV
- Fayette, WV
- Greenbrier, WV
- Jackson, WV
- Kanawha, WV
- Lincoln, WV
- Mason, WV
- Nicholas, WV
- Putnam, WV
- Raleigh, WV
- Roane, WV
- Sumners, WV
- Wayne, WV

BEA 54 (segment): Louisville, KY
- Clark, IN
- Crawford, IN
- Floyd, IN
- Harrison, IN
- Jefferson, IN
- Orange, IN
- Scott, IN
- Washington, IN
- Breckenridge, KY
- Bullitt, KY
- Grayson, KY
- Hardin, KY
- Henry, KY
- Jefferson, KY
- Meade, KY
- Nelson, KY
- Oldham, KY
- Shelby, KY
- Spencer, KY
- Trimble, KY
- Washington, KY

BEA 55 (segment): Evansville, IN
- Caldwell, KY
- Crittenden, KY
- Daviess, KY
- Hancock, KY
- Henderson, KY
- Hopkins, KY
- McLean, KY
- Muhlenberg, KY
- Ohio, KY
- Union, KY
- Webster, KY
- Edwards, IL
- Gallatin, IL
- Hamilton, IL
- Saline, IL
- Wabash, IL
- White, IL
- Dubois, IN
- Gibson, IN
- Perry, IN
- Pike, IN
- Posey, IN
- Spencer, IN
- Vanderburgh, IN
- Warrick, IN

BEA 62 (segment): Cincinnati, OH
- Dearborn, IN
- Franklin, IN
- Ohio, IN
- Ripley, IN
- Switzerland, IN
- Boone, KY
- Bracken, KY
- Campbell, KY
- Carroll, KY
- Fleming, KY
- Gallatin, KY
- Grant, KY
- Kenton, KY
- Lewis, KY
- Mason, KY
- Owen, KY
- Pendleton, KY
- Robertson, KY
- Adams, OH
- Butler, OH
- Brown, OH
- Clermont, OH
- Clinton, OH
- Hamilton, OH
- Highland, OH
- Warren, OH

(Continued)

Table A-1. (Continued)

BEA 64 (segment): Columbus, OH
- Athens, OH
- Guernsey, OH
- Hocking, OH
- Jackson, OH
- Morgan, OH
- Noble, OH
- Pike, OH
- Vinton, OH
- Washington, OH
- Pleasants, WV
- Ritchie, WV
- Wirt, WV
- Wood, WV

BEA 65 (segment): Clarksburg, WV
- Barbour, WV
- Doddridge, WV
- Harrison, WV
- Lewis, WV
- Marion, WV
- Monongalia, WV
- Preston, WV
- Taylor, WV
- Upshur, WV

BEA 66 (segment): Pittsburgh, PA
- Garrett, MD
- Belmont, OH
- Harrison, OH
- Jefferson, OH
- Monroe, OH
- Allegheny, PA
- Armstrong, PA
- Beaver, PA
- Butler, PA
- Clarion, PA
- Fayette, PA
- Greene, PA
- Indiana, PA
- Washington, PA
- Westmoreland, PA
- Brooke, WV
- Hancock, WV
- Marshall, WV
- Ohio, WV
- Tyler, WV
- Wetzel, WV

BEA 68 (segment): Cleveland, OH
- Carroll, OH
- Columbiana, OH

BEA 115 (segment): Paducah, KY
- Hardin, IL
- Johnson, IL
- Massac, IL
- Pope, IL
- Pulaski, IL
- Union, IL
- Ballard, KY
- Calloway, KY
- Graves, KY
- Livingston, KY
- Lyon, KY
- Marshall, KY
- McCracken, KY

Source: Robert R. Nathan Associates, Inc.

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B. Industrial Shippers and Receivers

Allied Chemical Corporation
Morriston, New Jersey

Denbo Iron and Metal Company
Decatur, Alabama

Jones and Laughlin Steel Company
Pittsburgh, Pennsylvania

St. Joseph Lead Company
Bellowsville, Pennsylvania

Union Carbide
Charleston, West Virginia

United States Steel Corporation
Pittsburgh, Pennsylvania

Wheeling - Pittsburgh Steel Corporation
Pittsburgh, Pennsylvania

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